OCCASIONAL PAPERS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

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No. 131, 38 pages, 32 figures, 3 tables

January 24, 1979

The Maritime Pseudoscorpions of Baja California, México

(Arachnida: Pseudoscorpionida)

By

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US ISSN 0068–5461

The California Academy of Sciences
Golden Gate Park
San Francisco, California 94118

PRINTED IN THE UNITED STATES OF AMERICA
BY ALLEN PRESS INC., LAWRENCE, KANSAS

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Abstract

Lee, Vincent F. The maritime pseudoscorpions of Baja California, México (Arachnida: Pseudoscorpionida). *Occasional Papers of the California Academy of Sciences*, No. 131, 38 pages, 32 figures, 3 tables, 1978.—Ten species of maritime pseudoscorpions are known from the beaches of Baja California, México. Of these, members of *Mexachernes carminis,* n.comb., and *Paraliochthonius johnstoni* are restricted to the littoral zone; members of the six species of *Garypus* and *Serianus litoralis* to the supralittoral zone; and members of *Menthus lindahli* do not appear to be limited to beaches. *Paraliochthonius mexicanus* Muchmore is synonymized with *P. johnstoni*. The six Baja species of *Garypus* are divided into two natural groups: the *californicus* group (*californicus* and *guadalupensis*) and the *giganteus* group (*giganteus, gracilis* n.sp., *pallidus*, and *sini*). The geographic distribution of maritime pseudoscorpions of Baja California correlates well with the pattern of sea currents. This relationship is based on the ability of pseudoscorpions to disperse via floating objects such as wrack and driftwood. Birds are probably of minor importance in affecting their dispersal.

Introduction

The pseudoscorpion fauna of Baja California is not well known. The first pseudoscorpion reported from this region is *Garypus giganteus* Chamberlin, a maritime species whose holotype was collected by members of the U.S.S. Albatross in 1906 (Chamberlin 1921). In 1921, Joseph C. Chamberlin was a member of a California Academy of Sciences expedition to the Gulf of California (Slevin 1923) and described the pseudoscorpions he collected, including some beach inhabitants (Chamberlin 1923). His work is the only one to date dealing with the entire Baja California area. Later, in a study of the stomach contents of a toad found in Cabo San Lucas, he described a new species of *Chernes* (Chamberlin 1925). In 1930, he described an endemic *Garypus* from Isla de Guadalupe and published additional records which had been editorially omitted from his 1923 paper (Chamberlin 1930b). Since then, the only new pseudoscorpion described from Baja California has been *Lamprochernes ellipticus* Hoff, a terrestrial species from the Colorado Desert (Hoff 1944).

The purpose of this study is to investigate the origin, distribution, and systematic affinities of the maritime pseudoscorpions found on the Baja California peninsula and islands, and in the adjacent Mexican states of Sonora and Sinaloa, through an examination of the literature, type-specimens, and specimens in major research collections. Most of the specimens and bionomical data in this study were obtained through several field expeditions carried out from 1969 to 1974. Species only occasionally found in the littoral and supralittoral zones, such as *Menthus rossi* (Chamberlin), are excluded from this study.

Material and Methods

Specimens were requested from major arachnological collections and from active arachnologists in the United States and México. However, only a small number of those from whom material was requested had pseudoscorpions from Baja California. The individuals and institutions from which specimens were borrowed or examined are the following, with the initials used to represent them: California Academy of Sciences (CAS); California State University, Long Beach (CSU–LB); David R. Malcolm (DRM); San Diego Museum of Natural History (SDMNH); University of California, Davis (UCD); Vincent D. Roth (VDR); William B. Muchmore (WBM); William G. Evans (WGE). Representative specimens in the writer's collection (VFL) will be deposited in the California Academy of Sciences collection.

Specimens that I collected were initially preserved in a solution containing approximately eight parts 75% isopropyl or ethyl alcohol and two parts glacial acetic acid. Later, they were transferred to 70 to 75% ethyl alcohol. Coloration was taken from freshly preserved specimens in alcohol, unless otherwise stated.

Slide preparations of representative individuals were made following dissection methods suggested by Chamberlin (1931) and Hoff (1949), and slide making procedures recommended by Ross (1953). This consisted of removing from each specimen one entire pedipalp, the chela of the other palp, one first and one fourth leg, and both chelicerae. These appendages were dehydrated through two baths of glacial acetic acid, then cleared in clove oil. While this was being done, the body was cleared in 10% potassium hydroxide solution. After clearing, it was washed in distilled water, the internal contents were pumped out, and the body was then processed through the procedures mentioned for the appendages. After one day in clove oil, or two or more days for thick-palped specimens, all parts were placed in xylene for at least ten minutes to remove the clove oil. Piccolyte was used as the mounting medium. The body and pedipalps were placed in a drop of the medium on a microscope slide with the venter of the body, the dorsal side of the entire pedipalp, and the extero-lateral side of the chela up. Three sections of monofilament line of proper thickness were used to support the cover glass. The remaining appendages were mounted under a separate cover glass without any support. Lightly pigmented and overcleared specimens were stained with acid fuchsin before the acetic acid baths. Lastly, the slides were dried in a thermostat-controlled oven set at 45°C for about a week.

Measurements were taken according to methods suggested by Chamberlin (1931), with the exception that the lengths of the trochanter and femoral segments of legs I and IV were measured along the longitudinal axis from the sclerotized tips of the podomeres. All observations of microscopic structures were made with a

compound microscope equipped with a calibrated ocular micrometer.

Chaetotaxic formulas used in this paper followed those used by Chamberlin in several of his papers. In some cases, complete chaetotaxy is given when it seems useful. In others, selected carapacial and abdominal chaetotaxies are used. In the formulas, certain specialized setae are designated as follows: d = dwarf seta on carapace of *Paraliochthonius johnstoni* (Chamberlin); P = pseudotactile seta; T = tactile seta. The symbol ± indicates maximum number of observable setae. Additional setae may be present but are obscured because of the preparation.

Names of localities used in this paper generally conform with those in *Lower California Guidebook* (Gerhard and Gulick 1967). Data from Chamberlin's slides were first confirmed using Slevin's 1923 report on the 1921 California Academy of Sciences expedition to the Gulf of California. Then when necessary, the locality name was changed to that used in Gerhard and Gulick's book. Label data from slides of the type-specimens in the type-data sections are not changed but are paraphrased. In this paper, "Baja" refers to Baja California (collectively, Estado de Baja California Norte and Estado de Baja California Sur); "Gulf" refers to the Gulf of California (Golfo de California); Cape region refers to the area around Cabo San Lucas, generally south of the Tropic of Cancer.

Acknowledgments

Field work for this study was partly supported by the National Science Foundation through research grant GB 23674 to its principal recipient Stanley C. Williams. Travel expenses for the 1970 expedition to the southern Gulf islands of Baja California were arranged by George E. Lindsay of the California Academy of Sciences through an American Association for the Advancement of Science student research grant. My appreciation goes to Mr. and Mrs. Richard F. Dwyer for their personal interest in my field work and their hospitality aboard their research vessel Sea Quest during this expedition. The Patterson Fund of the Department of Entomology at the California Academy of Sciences provided partial support for field studies in July–August 1974.

The laboratory part of this study was principally carried out at the California Academy of Sciences. Many thanks are accorded to Paul H. Arnaud, Jr. for making the type-specimens, research collections, and facilities of the Department of Entomology available for my use. The following individuals arranged for the loan of specimens from their personal collections or collections under their charge: Paul H. Arnaud, Jr., California Academy of Sciences; Ellen M. Benedict, Portland State University, Oregon (J. C. Chamberlin collection); William G. Evans, University of Alberta, Edmonton; Eric M. Fisher, California State University, Long Beach; David R. Malcolm, Pacific University, Forest Grove, Oregon (J. C. Chamberlin collection); William B. Muchmore, University of Rochester, New York; Vincent D. Roth, Southwestern Research Station, Portal, Arizona; and Robert O. Schuster, University of California, Davis. Thanks to the following individuals for donating specimens to my collection: Ernest Anderson, John T. Doyen, Thomas M. Glimme, and Stanley C. Williams. Myron Q. Chan loaned microscopic and other important research equipment. Keith Young illustrated the map of oceanic currents and gave clerical assistance. Lillian J. Dempster gave advice on taxonomic procedures. William B. Muchmore assisted in the proper generic assignment of *Chelanops carminis* Chamberlin. Stella E. Tatro helped in translating several German articles. Stanley C. Williams, James R. Sweeney, David C. F. Rentz, David H. Kavanaugh, Paul H. Arnaud, Jr., and Linda Zinn critically reviewed the manuscript. However, my deepest appreciation goes to Stanley C. Williams, who not only provided me with several opportunities to visit Baja California so that I could see at first hand the pseudoscorpions of this most interesting and unique area, but also for his guidance and encouragement during the course of this study.

General Description of Baja California and Oceanic Currents Affecting Its Coastline

Baja California is an 800-mile (1,290 km) long peninsula extending from the border of California in a south-southeasterly direction. The Pacific Ocean borders the west coast and the Gulf of California the east. Along both coasts are islands, but these islands are especially abundant on the Gulf side. The entire shoreline of the peninsula is estimated to be 3,500 miles (5,630 km) long, which compares well with California's

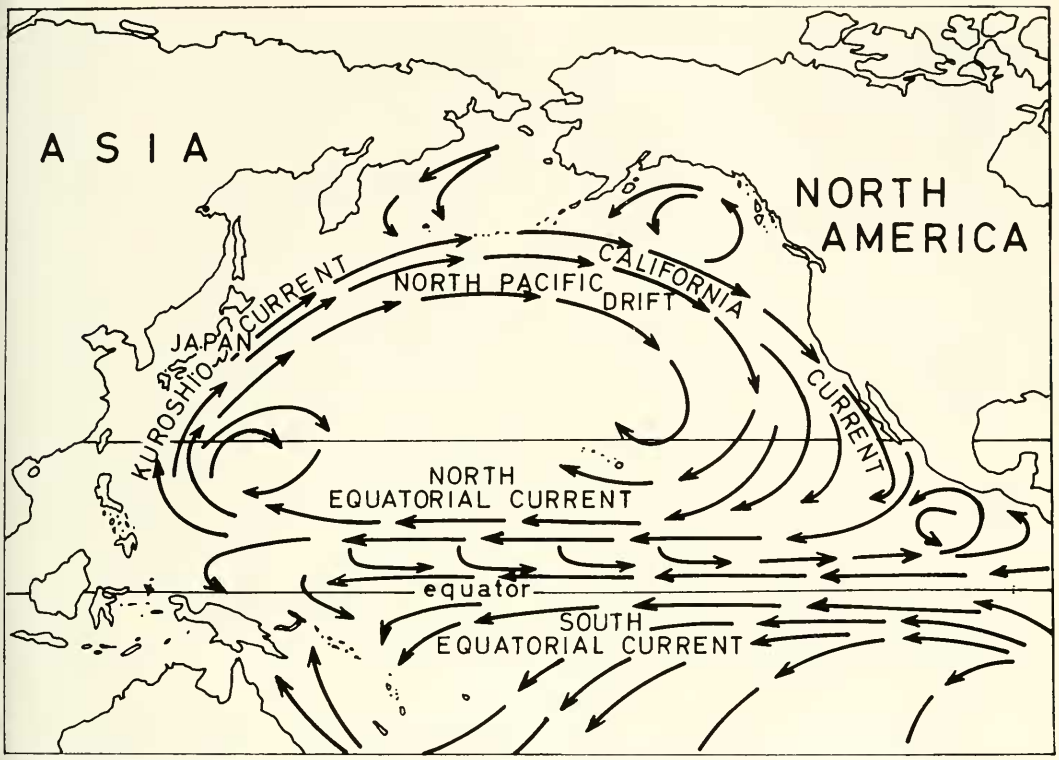


FIGURE 1. Major oceanic currents of the North Pacific Ocean. Excluded is the Davidson Current which is a countercurrent to the California Current (adapted from Kelley 1971).

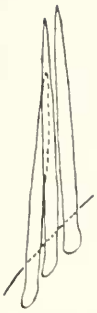
shoreline of 3,427 miles (5,515 km) (Kelley 1971).

The Pacific coast of Baja California is affected by fog and winter rains, especially in the region just south of the international border. The climate and vegetation there are not unlike that of the San Diego area. South of El Rosario, the central region is desert and becomes progressively drier, but it is still influenced by fog. The climate at the tip of the peninsula is tropical, with rains and occasional hurricanes in the summer.

On the eastern side of the peninsula, the climate is more continental. The islands and surrounding continental borderlands are extremely arid. In the northern parts of the Gulf, moisture from the Pacific cyclonic storms is mostly absorbed by the mountain ranges, leaving very little atmospheric moisture for the Gulf coast. Hurricanes occur in the region from Santa Rosalía to the tip of the peninsula (Hastings and Turner 1965; Soulé and Sloan 1966).

The distribution of littoral organisms is associated with their ability to disperse. As will be shown later, oceanic currents are suggested as playing a crucial role in the dispersal of maritime pseudoscorpions. Therefore, a discussion of the major currents of the North Pacific Ocean is important here. Detailed studies of the currents in the Gulf have not been made, so these currents will not be discussed.

The North Pacific gyral (Fig. 1), the great clockwise oceanic circulation of the North Pacific basin, impinges on the west coast of the continental United States by one of its arms, the south-flowing California Current. This current joins the west-flowing North Equatorial Current offshore at about latitude 25° north. Near the Asian continent, the warm Kuroshio Current flows north, passing the Philippine Islands and Japan. It picks up the cool Okhotsk Current and then moves eastward across the more northern latitudes of the North Pacific. Here it is called the North Pacific Drift or Current. The Subarctic Current merges into it south of the Aleutian chain. Near the Canadian border, this current



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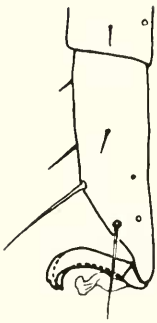

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divides into the smaller Alaska Current, which flows counterclockwise into the Gulf of Alaska, and the relatively cooler and larger California Current (Kelley 1971; Reid, Roden, and Wyllie 1958).

The Maritime Pseudoscorpions

Family Garypidae

Genus **Garypus** Koch

Diagnosis.—(Characteristics shared by *Garypus* species of Baja California.) Genus of medium- to large-sized (2.95 to 7.33 mm long) pseudoscorpions. Carapace triangular, widened posteriorly; anterior margin strongly bilobed, with four setae; posterior margin weakly concave; four strongly corneated eyes, anterior pair separated from posterior pair by about one-half ocular diameter, from anterior margin by about two to three ocular diameters; furrow of cucullus faint; two transverse furrows, both weak but discernible, posterior furrow most distinctive. Coxal area diverging posteriorly. Abdomen oval elongate; pleural membrane coarsely wrinkled; tergites 1 and 11 entire, tergites 2 to 10 divided medially; sternites 2, 3, and 11 entire, sternites 4 to 10 divided medially. Chelicera fairly stout; galea with four to six simple rami; serrula exterior with 20 to 32 ligulate blades; serrula interior with 17 to 28 blades fused into a velum; lamina exterior present as a thin velum; subapical lobe of movable finger strongly sclerotized and acute; fixed finger with six to ten marginal teeth; five acuminate setae on palm, normally distributed; galeal seta short, not reaching apex of galea. Palp extremely slender to stout; vestitural setae numerous, short and acute or nearly so, longer and more abundant on fingers. Chela with venom apparatus on each finger; fixed finger with eight tactile setae, *eb*, *esb*, and *isb* at

←

Figures 2 to 6. Characteristics of the genus *Garypus* of taxonomic importance. Fig. 2. *Garypus californicus* Banks, male from Bolinas, California, setae of flagellum. Fig. 3. *Garypus sini* Chamberlin, male from Bahía de los Ángeles, Baja California Norte, México, setae of flagellum. Fig. 4. *Garypus californicus*, male from ten miles (16 km) north of Laguna Manuela, Baja California Norte, México, tarsal articulation of fourth walking leg. Most setae omitted. Fig. 5. *Garypus gracilis* Lee, new species, holotype male from Isla Danzante, Baja California Sur, México, tarsal articulation of fourth walking leg. Most setae omitted. Fig. 6. *Garypus californicus*, male from Coronado, California, pleural membrane of eighth abdominal sclerite, lateral view. T = tergite.

base of finger on exterior face, usually more or less aligned, *est* isolated on middle part of finger, *et* near finger tip, *it* nearer to *et* than to *est* and on dorsum of finger; movable finger with four tactile setae, *b* and *sb* basally grouped, *st* on middle part of finger, *t* near finger tip. Legs moderately hirsute on all surfaces, setae of trochanter, basifemur, and telofemur stout, setae on extensor surfaces of moderate length, and longest on depressor surfaces of tibia, metatarsus, and telotarsus.

Remarks.—As will be discussed below, couplet 5 of the key segregates *Garypus* into two groups of species: the *californicus* group which includes *G. californicus* Banks and *G. guadalupensis* Chamberlin; and the *giganteus* group which includes *G. giganteus* Chamberlin, *G. pallidus* Chamberlin, *G. sini* Chamberlin, and *G. gracilis* Lee, new species. These groups appear to be natural divisions based on the characteristics given in the key below.

Garypus californicus Banks

(Figures 2, 4, 6–8, 30)

Garypus californicus Banks, 1909: 305 (original description); Banks 1911: 635, fig. 210B; Moore 1917: 26, fig. 1; Moles and Moore 1921: 8, fig. on p. 8; Chamberlin 1921: 190, 191 (key), figs. A–D; Chamberlin 1925: 330; Chamberlin 1930a: figs. 2J, O, S, Z, 3P, S; Chamberlin 1930b: 613; Chamberlin 1931: figs. 3, 4C, 6C, 8B, 11P, 14C, D, 16N, 17W, 19J, 21D, 24A, 26A, 29F, 40U, 41E, F, 45O, 46L, 47F, T, 50F; Beier 1932a: 217 (key), 219–220, fig. 246; Pratt 1935: 480; Roewer 1937: 268 (listed); Cockerell 1940: 294; Beier 1952: 238 (key); Ricketts and Calvin 1952: 431; Light et al. 1954: 197; Takashima 1955: 176 (listed); Roth and Brown 1976: 128; Schulte 1976: 119–123 (biological data).

Diagnosis.—Medium-size species (3.84 to 5.69 mm long); 9 to 14 setae on posterior margin of carapace, derm granulated; posterior tergites granulated; pleural membrane with setae; setae of flagellum acuminate; palps moderately slender; legs with oblique tarsal articulation.

Garypus californicus is most nearly like *G. guadalupensis* Chamberlin from which its members differ by their smaller size, fewer number of setae on posterior margin of carapace, and more robust appendages.

Female characteristics.—Data based on one female from Puerto de Santo Tomás, nine females from 15 miles (24 km) N of El Rosario, two females from 10 miles (16 km) N of Miller's Landing, and five females from 10 miles (16 km) N of Laguna Manuela.

Coloration (of other specimens in alcohol): Carapace dark dusky brown with two non-melanic spots near posterior margin; pedipalp light brown; legs buff to light brown; tergites dusky brown on edges of tergal halves, tergites 1 to 3 uniformly dusky brown but tergites 4 to 10 with dark central spot on each tergal half; sternites 6 to 10 with similar spot design; pleural membrane buff.

Carapace with length slightly greater than posterior breadth; derm strongly granulated, more or less equally well developed throughout carapace except for light sclerotization of two spots near posterior margin; posterior margin with poorly defined row of 10 to 14 setae near the margin.

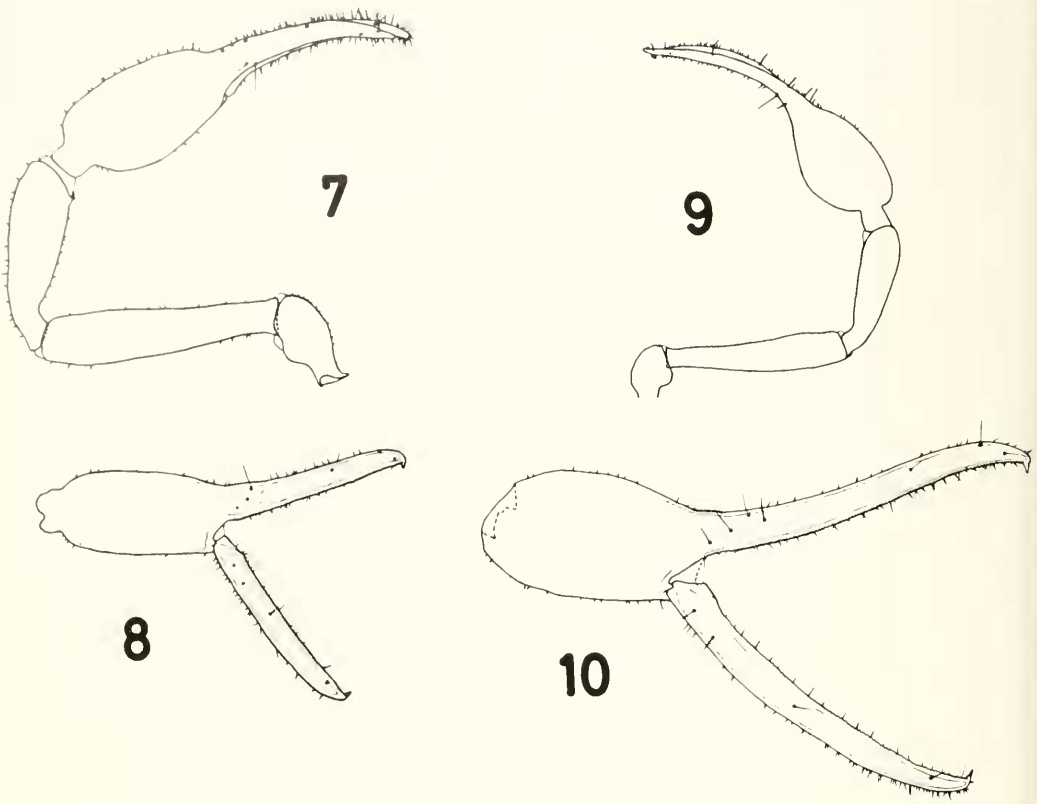
Abdomen with pleural membrane setigerous on dorsal part and on ventral and median parts of terminal segments, usually two to four setae per fold; derm of tergites strongly granulated on anterior segments, becoming lightly granulated on posterior ones; chaetotaxy of tergites 1 to 10: 9–16:10–15:11–15:13–18:14–20:13–18:15–19:15–21:15–20:14–20. Sternites with light reticulations on anterior segments, becoming granular on posterior ones; chaetotaxy of sternites 2 to 10: 15–22:9–12:8–12:11–16:11–16:11–16:12–19:13–18:13–21.

Flagellum of chelicera with three setae, anterior one longest, posterior two about the same length, each seta stout, smooth, without lateral denticulations, rarely with apical branchings.

Palp of typical facies, relatively slender; derm granular on all surfaces except fingers. Palpal proportions: trochanter 1.5–1.8, femur 4.0–4.8, tibia 2.9–3.4, and chela without pedicel 2.9–3.7 times as long as broad; movable finger 1.2–1.3 (rarely 1.4) times as long as hand.

Chela moderately slender; derm of hand coarsely granular, of fingers finely granular to smooth; fingers relatively straight, not strongly gaping; fixed finger with 73 to 90 teeth, more or less equally well developed; movable finger with 63 to 72 teeth. Chaetotaxy of chela similar to other members of *Garypus*, with *st* of movable finger nearer to *sb* than to *t*.

Legs of typical structure; derm granular, well-developed granulations on telofemur of leg IV; articulation between metatarsus and telotarsus of all legs oblique. Leg I proportions: trochanter 1.4–2.0, basifemur 3.3–3.9, telofemur 1.8–2.3, tibia 3.6–4.6, metatarsus 3.1–3.8, and telotarsus 3.2–3.7 times as long as deep. Leg IV propor-



FIGURES 7 to 10. Figs. 7 and 8. *Garypus californicus* Banks, female from ten miles (16 km) north of Laguna Manuela, Baja California Norte, México. Fig. 7. Dorsal view of pedipalp. Fig. 8. Extero-lateral view of chela. Figs. 9 and 10. *Garypus guadalupensis* Chamberlin, holotype female from Isla de Guadalupe, Baja California Norte, México. Fig. 9. Dorsal view of pedipalp. Fig. 10. Extero-lateral view of chela (at greater magnification than dorsal view).

tions: trochanter 1.9–2.2, basifemur 1.6–1.8, telofemur 3.4–4.6, tibia 5.9–7.6, metatarsus 3.4–4.3, and telotarsus 3.1–3.9 times as long as deep.

Measurements (in millimeters): body length 4.46–5.69; abdomen 3.51–4.34 by 2.64–3.38. Carapace: median sclerotized length 1.25–1.38, ocular breadth 0.71–0.87, posterior breadth 1.07–1.40. Chelicera 0.38–0.41 long by 0.22–0.28 broad.

Palp: trochanter 0.64–0.74 by 0.40–0.43, femur 1.29–1.82 by 0.31–0.41, tibia 1.04–1.44 by 0.33–0.46, chela without pedicel 2.00–2.59 by 0.59–0.76, hand 0.91–1.20 long and 0.56–0.66 deep, movable finger 1.16–1.50.

Leg I: trochanter 0.37–0.48 by 0.24–0.29, basifemur 0.67–0.82 by 0.19–0.23, telofemur 0.37–0.50 by 0.17–0.25, tibia 0.50–0.63 by 0.12–0.16, metatarsus 0.33–0.42 by 0.09–0.12, telotarsus 0.28–0.38 by 0.09–0.11. Leg IV: trochanter 0.57–0.67 by 0.26–0.32, basifemur 0.42–0.52 by 0.24–0.30, telofemur 1.09–1.23 by 0.27–0.35, tibia 1.14–1.24 by 0.15–0.20, metatarsus 0.48–0.54 by 0.12–0.15, telotarsus 0.41–0.45 by 0.11–0.14.

MALE CHARACTERISTICS.—Data based on one male from Puerto de Santo Tomás, 11 males from 15 miles (24 km) N of El Rosario, six males from 10 miles (16 km) N of Miller's Landing, six males from 10 miles (16 km) N of Laguna Manuela, and one male from Isla Asunción. Not significantly different from female characteristics except for the smaller size. Most setal counts and appendicular proportions come within the ranges described for the female. Chaetotaxy of genital segments (sternites 2 and 3): 21–35: (6–8)(6–7)/9–13.

TYPE-DATA.—The two syntypes (sex not stated) of *Garypus californicus* Banks were collect-

ed from Palo Alto and San Nicolas Island, California (Banks 1909). They are deposited in the Museum of Comparative Zoology, Harvard University.

Geographic Distribution and Habitat.—Known from many localities in California, from Trinidad south to Isla de Guadalupe and Isla Asunción, Baja California Sur (38°14'N to 27°07'N).

Members of this common species have been reported from under rocks, driftwood, and wrack on sandy and cobblestone beaches; under boards in salt marshes; and under bark of wooden piles used as a breakwater. In Baja California, individuals were reported from Ensenada (Ricketts and Calvin 1952). At Puerto de Santo Tomás, specimens were collected from a cobblestone beach adjacent to a sedimentary headland, where they occupied holes in stones excavated by burrowing clams. The stones were right on the water line. Other specimens were found under kelp washed up to slightly above the high-tide line. Further south on the beaches of Bahía de Sebastián Vizcaíno, individuals were found under semi-dried kelp accumulation atop cobblestone beaches. At El Tomatal, the surfgrass wrack was also found to harbor members of this species.

Specimens examined.—Published records. MÉXICO. *Baja California Norte:* Isla de Guadalupe, Jack's Bay, 16 July 1922, G D. Hanna, J. R. Slevin, 1 female (DRM). *Baja California Sur:* Isla Asunción, 1 Aug. 1922, G D. Hanna, J. R. Slevin, 1 male (DRM). These specimens were determined by Chamberlin as *G. giganteus* Chamberlin.

New records. MÉXICO. *Baja California Norte:* Puerto de Santo Tomás, 11 July 1969, S. C. Williams, V. F. Lee, 1 male, 1 female (VFL); Isla San Martín, N side, 23 Feb. 1973, C. R. Mahrot, 1 male, 1 female (CAS); Socorro dunes, 1.4 km NW of El Socorro, 17 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 10 males, 18 females, 8 tritonymphs (VFL); 15 miles (24 km) N of El Rosario, 2 Aug. 1938, E. S. Ross, A. E. Michelbacher, 18 males, 9 females (CAS); Socorro dunes, 1.3 km NW of El Consuelo, 17 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 17 males, 8 females, 2 tritonymphs (VFL); El Tomatal, 18 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 5 males, 1 tritonymph, 1 deutonymph, 2 protonymphs (VFL); 10 miles (16 km) N of Miller's Landing, 29 July 1938, E. S. Ross, A. E. Michelbacher, 6 males, 2 females (CAS); Miller's Landing, 7 Apr. 1976, J. T. Doyen, 7 males, 4 females (VFL); 63.6 km N of Guerrero Negro, on road to Miller's Landing, 8 Aug. 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 26 males, 11 females, 6 deutonymphs, 1 protonymph (VFL); 10 miles (16 km) N of Laguna Manuela (=Santo Domingo Landing), 21 June 1938, E. S. Ross, A. E. Michelbacher, 6 males, 5 females, 1 protonymph (CAS).

Remarks.—Figures 4C and 14C of Chamberlin's 1931 work might not have been based on specimens of *Garypus californicus*, as captioned. In most individuals, the cheliceral flagellar setae are acuminate. In some, they are apically branched, but in none are they laterally denticulate, as in members of the *giganteus* group. Chamberlin's illustrations were probably drawn from a member of the *giganteus* group.

The female from Isla de Guadalupe differs from peninsular specimens by its larger size, ratio of length of movable finger to length of hand which is 1.4, and slightly more hirsute abdomen. It appears to be more closely related to individuals of *G. californicus* from San Nicolas Island off the California coast than to the continental populations.

Garypus guadalupensis Chamberlin

(Figures 9, 10, 30)

Garypus guadalupensis Chamberlin, 1930b: 614–615 (original description); Beier 1932a: 217 (key), 221; Roewer 1937: 286 (listed); Beier 1952: 238 (key); Takashima 1955: 176 (listed).

Garypus guadelupensis [sic]: Chamberlin 1931: figs. 8A, 33D, 37P, Q.

Diagnosis.—Large species (about 5.61 mm long); posterior margin of carapace with five setae; pleural membrane hirsute as in members of *Garypus californicus*; posterior tergites lightly granulated; setae of flagellum acuminate; palpal segments extremely slender, movable finger of chela 1.8 times as long as hand; tarsal articulation oblique.

The nearest congener is *G. californicus* from which individuals can be easily distinguished by the more attenuated pedipalps, and by the larger size. Other distinctive features include fewer setae on the posterior margin of the carapace, greater number of blades on the serrula exterior and serrula interior, greater ratio of length of movable finger to length of hand, and greater number of teeth on the fingers of the palpal chela.

Redescription of the Holotype Female.—Carapace with length longer than posterior breadth; derm with granulations similar to *G. californicus* individuals; posterior margin with about five setae.

Pleural membrane of abdomen with setation as in *G. californicus* individuals; surface of tergites strongly granulated on anterior segments, becoming lightly granulated posteriorly; chaetotaxy of tergites 1 to 10: 14:16:16:15±: 17:18:19:17:19:20. Sternites smooth to faintly

reticulated on anterior three segments, becoming granular posteriorly; chaetotaxy of sternites 2 to 10: 26:11:11:13:18:16:15:16:15.

Chelicera typical; serrula exterior with 30 or 31 blades; serrula interior with 28 blades; flagellum with three setae, the anterior one missing, posterior two about the same length, each seta with about four apical branchings.

Palp of typical generic facies, extremely slender; derm lightly granular on palm but with distinct granules on dorsal and ventral sides, especially at base of fingers, fingers smooth. Palpal proportions: trochanter 1.7, femur 5.3, tibia 3.5, and chela without pedicel 3.9 times as long as broad; movable finger 1.8 times as long as hand.

Chela extremely attenuated, fingers strongly curved and gaping; movable finger distinctly shorter than fixed finger; fixed finger with 106 well-defined retroconical teeth with basal ones slightly shorter, movable finger with 94 teeth, the distal ones strongly retroconical, the proximal ones with their apices rounded. Chaetotaxy as usual for genus, with *est* distal to midpoint of fixed finger and distinctly nearer to *it* than *ist*, *ist* anterior to *esb*, *st* of movable finger nearer to *sb* than to *t*.

Legs of typical structure; derm of all podomeres granular, with well-developed granulations on telofemur of leg IV; tarsal articulation strongly oblique as in *G. californicus* members. Leg I proportions: trochanter undeterminable, basifemur 4.3, telofemur 2.7, tibia 5.4, metatarsus 4.7, and telotarsus 4.2 times as long as deep. Leg IV proportions: trochanter 2.4, basifemur 1.8, telofemur 4.0, tibia 9.0, metatarsus 5.1, and telotarsus 4.5 times as long as deep.

Measurements (in millimeters): body length 5.61; abdomen 3.93 by 3.07. Carapace: median sclerotized length 1.79, ocular breadth 0.94, posterior breadth 1.70. Chelicera 0.48 long by 0.34 broad.

Palp: trochanter 0.96 by 0.56, femur 2.54 by 0.48, tibia 1.90 by 0.54, chela without pedicel 4.09 by 1.04, hand 1.44 long and 0.94 deep, movable finger 2.62 long.

Leg I: trochanter length undeterminable by 0.34, basifemur 1.14 by 0.27, telofemur 0.68 by 0.25, tibia 0.92 by 0.17, metatarsus 0.61 by 0.13, telotarsus 0.51 by 0.12. Leg IV: trochanter 0.88 by 0.36, basifemur 0.65 by 0.36, telofemur 1.67 by 0.42, tibia 1.72 by 0.19, metatarsus 0.80 by 0.16, telotarsus 0.61 by 0.14.

Type-Data.—The holotype female of *Garypus guadalupensis* Chamberlin was collected from Jack's Bay, Guadalupe Island, Lower California, México, on 16 July 1922 by [G D.] Hanna and [J. R.] Slevin. It is mounted on a microscope slide and is deposited in the California Academy of Sciences.

Geographic Distribution.—Known only from Isla de Guadalupe, Baja California Norte (29°00′N, 118°16′W).

Specimen Examined.—Published record. MÉXICO. *Baja California Norte*: Isla de Guadalupe, Jack's Bay, 16 July 1922, G D. Hanna, J. R. Slevin, holotype (CAS Type No. 8703).

Remarks.—This species is known only from the holotype. Its members are endemic to Isla de Guadalupe where they are sympatric with those of *Garypus californicus*. Gigantism, as shown in this species, is a common phenomenon shared by many insular organisms.

Garypus giganteus Chamberlin

(Figures 11, 12, 30)

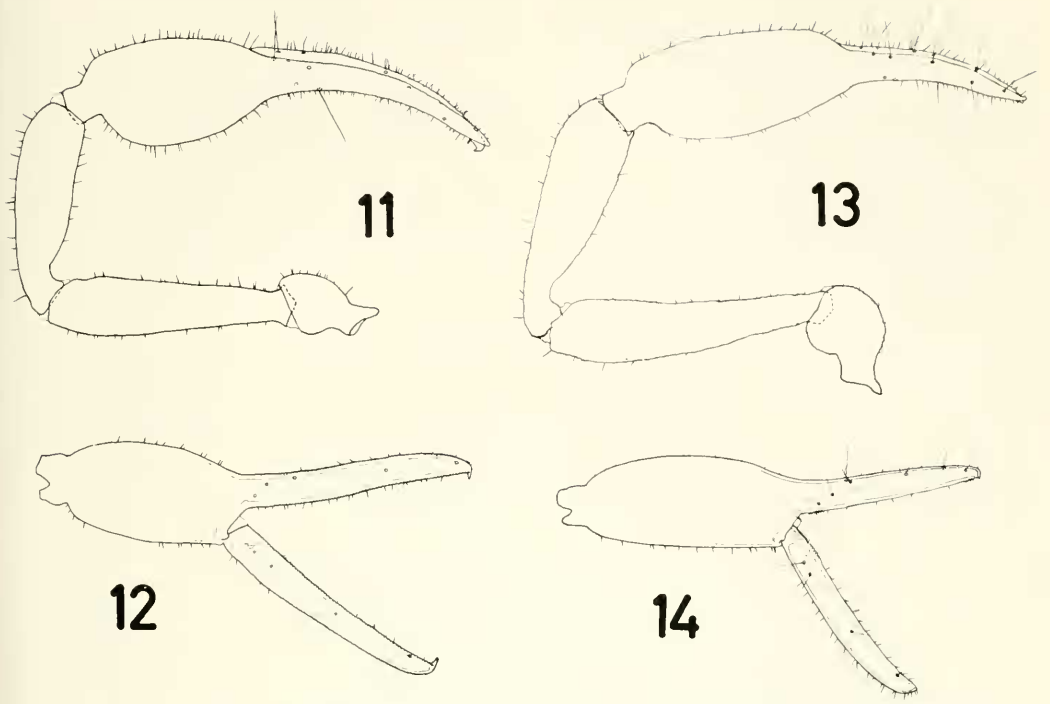
Garypus giganteus Chamberlin, 1921: 186, 188–190 (original description), 191 (key), pl. 7 (figs. A–G); Chamberlin 1923: 360–361; Chamberlin 1930b: 613–614; Beier 1932a: 217 (key), 218; Roewer 1937: 268 (listed); Beier 1952: 238 (key); Takashima 1955: 176 (listed).

Diagnosis.—Medium to large size (4.49 to 7.33 mm long); carapace with derm of posterior furrow distinctly reticulated, six to eight setae on posterior margin; pleural membrane bare; posterior tergites pseudosquamose; setae of cheliceral flagellum with lateral denticles; palps relatively slender, derm granulated; chela with five to eight microsetae near tactile seta *b;* leg tarsal articulation nearly transverse.

Superficially, individuals of this species resemble *Garypus gracilis* Lee, new species described below. They differ by their larger size, greater number of teeth on the chelal fingers, the tendency for greater setal counts on sternites 5 to 10, lower ratio of the lengths of the chelal movable finger to hand, greater number of teeth (seven to ten) on the fixed finger of the chelicera, and uniformly granular derm of the palps.

Redescription of the Holotype Female.—Derm of carapace lightly to strongly granular on lateral surfaces and distinctly netlike on posterior furrow; posterior margin with seven setae.

Abdomen typical; surface of anterior tergites granulo-reticulated, becoming pseudosquamose on segments 8 to 11; chaetotaxy of tergites 1 to



FIGURES 11 to 14. Figs. 11 and 12. *Garypus giganteus* Chamberlin, male from ten miles (16 km) north of Laguna Manuela, Baja California Norte, México. Fig. 11. Dorsal view of pedipalp. Fig. 12. Extero-lateral view of chela. Figs. 13 and 14. *Garypus pallidus* Chamberlin, topotype male from Isla Cerralvo, Baja California Sur, México. Fig. 13. Dorsal view of pedipalp. Fig. 14. Extero-lateral view of chela.

10: 8:7:6:12:12:14:15:16:16:13. Sternites faintly reticulated on anterior segments, becoming pseudosquamose on posterior segments; chaetotaxy of sternites 2 to 10: 20:9:9:14:16:14:18: 14:15.

Flagellum of chelicera with three setae, anterior one longest, posterior ones of approximately the same length, each seta slender and flattened, with well-defined lateral denticles on distal half, the denticles appear to be biramous.

Palp of typical generic facies, relatively slender; derm granulated, granules small and well spaced, granules of fingers larger and more pronounced. Palpal proportions: trochanter 1.7, femur 3.6, tibia 3.2, and chela without pedicel 3.1 times as long as broad; movable finger 1.5 times as long as hand.

Chela moderately slender; fingers slightly curved and gaping; teeth of fingers difficult to observe, fixed finger with more than 95 teeth, movable finger with 79 teeth. Chaetotaxy of chela usual for genus, with *est* of fixed finger nearer to *it* than to *ist;* five or six microsetae located dorsal to *b* of movable finger.

Legs of typical structure; derm of podomere lightly to moderately pseudosquamose, best developed on telofemur of leg IV; articulation between metatarsus and telotarsus of all legs nearly transverse. Leg I proportions: trochanter undeterminable, basifemur 3.6, telofemur 2.2, tibia 4.4, metatarsus 3.1, and telotarsus 3.0 times as long as deep. Leg IV not properly mounted for determining proportions.

Measurements (in millimeters): body length 6.93, abdomen 5.16 by 4.01. Carapace: median sclerotized length 1.58, ocular breadth 1.05, posterior breadth 1.57. Chelicera 0.47 long by 0.31 broad.

Palp: trochanter 0.78 by 0.46, femur 1.70 by 0.48, tibia 1.55 by 0.48, chela without pedicel 2.85 by 0.92, hand 1.19 long, movable finger 1.78 long.

Leg I: trochanter undeterminable, basifemur 0.78 by 0.22, telofemur 0.48 by 0.22, tibia 0.66

by 0.15, metatarsus 0.37 by 0.12, telotarsus 0.39 by 0.13. Leg IV not properly mounted for measuring.

Variation of Other Mounted Females.—Data based on females listed below except for the holotype. Not much different from holotype. Chaetotaxy of abdominal sclerites generally not varying more than three setae from holotype chaetotaxy. Chaetotaxy of genital segments: anterior operculum with 16 to 25, posterior operculum with 8 to 11 setae. Palpal proportions: trochanter 1.6–1.8, femur 3.6–4.2, tibia 2.9–3.5, and chela without pedicel 3.2–3.6 times as long as broad; movable finger 1.4–1.6 times as long as hand. Fixed finger of chela with 95 to 109 cuspid teeth, apical teeth strongly conical but reduced in height posteriorly; movable finger with 76 to 87 teeth, teeth well developed as are the dental canals, apical teeth strongly conical, becoming retroconical toward base of finger. Five to seven microsetae near *b*, rarely is part of group located between *sb* and *b*.

Male Characteristics.—Data based on males listed below. Similar to female but smaller. Chaetotaxy of carapace, tergites, and sternites like the female; chaetotaxy of sternites 2 and 3: 26–38:(10–16)(8–15)/7–10. Palps not showing strong sexual dimorphism; proportions in male tend to be more slender: trochanter 1.5–1.7, femur 3.6–4.5, tibia 3.0–3.6, and chela without pedicel 3.4–3.9 times as long as broad; movable finger 1.3–1.5 times as long as hand.

Type-Data.—The holotype female of *Garypus giganteus* Chamberlin was collected from Turtle Bay, Magdalena Bay, Lower California, México, on 20 Apr. 1906 by [members of the] U.S.S. Albatross. It is mounted on a microscope slide and is deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Known from a restricted region of the Vizcaíno Desert on the Pacific coast of Baja California from Miller's Landing to Bahía Magdalena (28°35′N to 24°35′N). Edward S. Ross (personal communication) indicated that he found individuals of this species under kelp on the beaches of Bahía de Sebastián Vizcaíno. They are also found under stones and debris just above the high tide line, and in rock crevices at the back of a beach.

Specimens Examined.—Published records. MÉXICO. *Baja California Sur:* Bahía Tortugas, 20 Apr. 1906, U.S.S. Albatross, holotype (CAS Type No. 748); Isla Asunción, 1 Aug. 1922, G D. Hanna, J. R. Slevin, 6 males, 2 females (CAS, DRM).

New records. MÉXICO. *Baja California Norte:* 10 miles (16 km) N of Miller's Landing, 29 July 1938, E. S. Ross, A. E. Michelbacher, 3 females (CAS); 10 miles (16 km) N of Laguna Manuela (=Santo Domingo Landing), 21 June 1938, E. S. Ross, A. E. Michelbacher, 5 males, 4 females (CAS). *Baja California Sur:* Bahía Tortugas, 10–15 Nov. 1974, E. Anderson, 5 males, 2 females, 1 tritonymph, 1 deutonymph (VFL); Bahía Magdalena, 1 June 1968, W. G. Evans, 5 males, 8 females, 11 tritonymphs, 1 deutonymph, 19 protonymphs (WGE).

Garypus pallidus Chamberlin

(Figures 13, 14, 30)

Garypus pallidus Chamberlin, 1923: 362–363 (original description), pl. 3 (fig. 7); Chamberlin 1930b: 613; Beier 1932a: 216 (key), 218; Roewer 1937: 268 (listed); Beier 1952: 238 (key); Takashima 1955: 176 (listed); Roth and Brown 1976: 128.

Diagnosis.—Small species of *Garypus* (2.95 to 3.52 mm long); carapace with five or six setae on posterior margin; pleural membrane bare; setae of cheliceral flagellum with lateral denticles; palps slender, derm imbricated; chelal movable finger 0.93–1.1 times as long as hand; one or two microsetae near *b*; tarsal articulation of legs nearly transverse.

This species is probably the smallest *Garypus* known. It differs from the other members of the *giganteus* group by its smaller size (up to 4.0 mm), characteristic carapacial patterning, imbricated derm of the palp, more slender pedipalps, lower ratio of lengths of the movable finger to the hand, and fewer microsetae near tactile seta *b* of the movable finger of the chela.

Redescription of the Holotype Male.—Carapace of usual shape; derm rugose throughout most of carapace, appears pseudosquamose with flakelike imbrications on some parts, strongly reticulated on posterior furrow; posterior margin with six setae.

Abdomen typical; dermal structure of tergites as that described for *Garypus giganteus*; chaetotaxy of tergites 1 to 10: 11±:7:7:10:10:11:11:14:14:13. Derm of most sternites pseudosquamose; chaetotaxy of sternites 2 to 10: 19:(13)(12)/9:10:11:12:13:13:13:13.

Flagellum of chelicera similar in form to individuals of *G. giganteus* but with fewer spinules on each seta.

Palp relatively slender; derm with coarse granules on chela, on other segments developed as featherlike imbrications, especially on the pedicels. Palpal proportions: trochanter 1.4, fe-

mur 4.1, tibia 3.4, and chela without pedicel 3.8 times as long as broad; movable finger 1.0 times as long as hand.

Chela moderately slender; fingers not strongly gaping, nearly straight; teeth on both fingers strongly retroconical, with apices of proximal teeth lower and more rearward projecting; fixed finger with 64 teeth; movable finger with 51 teeth. Chaetotaxy typical for genus, with these notable features: *est* of fixed finger slightly distal to midpoint and nearer to *it* than to *ist*, *st* of movable finger slightly distal to midpoint and nearer to *t* than to *sb*; one or two microsetae dorsal and posterior to tactile seta *b* of movable finger.

Legs of usual shape; derm strongly pseudosquamose; tarsal articulation nearly transverse. Legs not properly mounted for determining proportions.

Measurements (in millimeters): body length 3.14; abdomen 2.18 by 1.53. Carapace: median sclerotized length 0.98, ocular breadth 0.58, posterior breadth 1.00. Chelicera not properly mounted for measuring.

Palp: trochanter 0.43 by 0.30, femur 1.14 by 0.28, tibia 1.01 by 0.30, chela without pedicel 1.63 by 0.43, hand 0.83 long, movable finger 0.86 long.

Legs not properly mounted for measuring.

Variation of Other Mounted Males.—Data based on two paratopotypes, one topotype, and one male from Cabo San Lucas. Similar to holotype. Male from Cabo San Lucas slightly larger than specimens from type-locality. Coloration (of other specimens in alcohol): Carapace dusky-brown with light band across posterior margin, two light spots symmetrically placed slightly anterior to this band; chela dusky-brown but other palpal segments lighter; tergites and sternites also dusky-brown; legs and coxae buff. Carapacial posterior margin with five or six setae. Chaetotaxy of tergites and sternites usually varying within three setae of holotype chaetotaxy. Chaetotaxy of sternites 2 and 3: 21–29:(9–11)(8–11)/8–12. Palpal proportions: trochanter 1.5–1.7, femur 4.1–4.4, tibia 3.3–3.8, and chela without pedicel 3.5–4.3 times as long as broad; movable finger 0.93–1.1 times as long as hand.

Redescription of the Allotype Female.—Basically similar to male, larger than males from type-locality. Chaetotaxy of tergites and sternites similar to males with usual exception of genital area: anterior operculum with ten, posterior one with seven setae. Palpal femur and tibia stouter than males. Palpal proportions: trochanter 1.6, femur 3.3, tibia 2.9, and chela without pedicel 3.4 times as long as broad; movable finger 1.1 times as long as hand. One microseta near *b*.

Measurements (in millimeters): body length 3.52, abdomen 2.52 by 1.90. Carapace: median sclerotized length 1.04, ocular breadth 0.72, posterior breadth 1.12. Chelicera not properly mounted for measuring.

Palps: trochanter 0.53 by 0.33, femur 1.20 by 0.36, tibia 1.11 by 0.38, chela without pedicel 1.82 by 0.53, hand 0.91 long, movable finger 0.97.

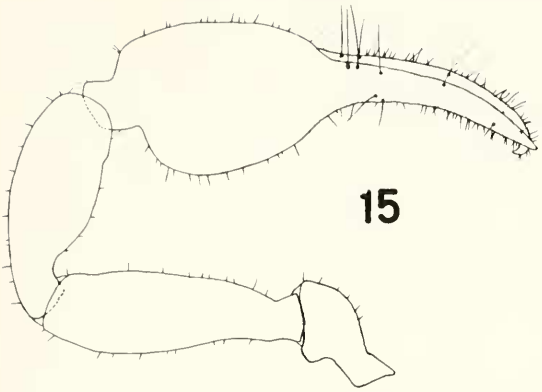
Legs not properly mounted for measuring.

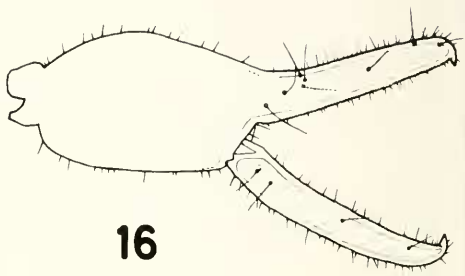
Type-Data.—The holotype male and allotype female of *Garypus pallidus* Chamberlin were collected from Gordas Point, Ceralbo Island, Gulf of California, México, on 6 June 1921 by J. C. Chamberlin. These types are mounted on microscope slides and are deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Known from Isla Cerralvo and a few beaches around the Cape region, Baja California Sur and from Salina Cruz, Oaxaca. The geographic range is from 24°15′N to 16°10′N. Chamberlin (1923) collected individuals of this species under stones along rocky or sandy beaches. I collected specimens from barren sandy beaches. For instance, the beach near Todos Santos is practically a stretch of white sand, interspersed with very small pieces of cholla driftwood, most of them less than 12 cm long, which had been accumulated by the previous winter's highest tides. Under these pieces of driftwood was a diverse community of numerous small arthropods. These isolated microhabitats not only serve as sheltering places, but also as feeding grounds for micropredators such as members of *Garypus pallidus*. The specimens from Salina Cruz were collected from rock crevices at the splash (=supralittoral) zone.

Specimens Examined.—Published records. MÉXICO. *Baja California Sur:* Isla Cerralvo, Piedras Gordas, 6 June 1921, J. C. Chamberlin, holotype (CAS Type No. 1270), allotype (CAS Type No. 1271), 2 paratype males, 5 paratype tritonymphs (CAS, DRM).

New records. MÉXICO. *Baja California Sur:* Isla Cerralvo, SW end, 26 May 1962, W. Farmer, R. Banks, 2 males, 1 female, 2 tritonymphs (SDMNH); 3.2 km SE of La Ribera, 26 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 20 males,





FIGURES 15 and 16. *Garypus sini* Chamberlin, male from Bahía de los Ángeles, Baja California Norte, México. Fig. 15. Dorsal view of pedipalp. Fig. 16. Extero-lateral view of chela.

15 females, 2 tritonymphs (VFL); Todos Santos, sandy beach near estero, 23 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 31 males, 24 females, 6 tritonymphs (VFL); Rancho Migriño, 6 Aug. 1974, T. S. Briggs, M. Dang, K. Hom, W. Lum, J. Tom, M. Wong, 1 male, 2 females (VFL); Cabo San Lucas, 29 Apr. 1947, I. LaRivers, 1 male (UCD); Cabo San Lucas, 11 & 12 June 1973, E. L. Sleeper, 1 male (CSU–LB). *Oaxaca:* Salina Cruz, 20 May 1968, W. G. Evans, 3 males (WGE).

REMARKS.—The record from Salina Cruz extends the distribution of this species by more than 1,650 km (airline distance) from the type-locality. The palpal proportions of a Salina Cruz male tend to be a little (but not significantly) more slender than males from the Cape region. The body is also a little larger, by about 0.5 mm. The Salina Cruz specimens represent the only known collection of *Garypus* pseudoscorpions from south of the Gulf of California in the New World.

Garypus sini Chamberlin

(Figures 3, 15, 16, 30)

Garypus sine [sic]: ROEWER 1937: 268 (listed).

Garypus sini CHAMBERLIN, 1923: 361–362 (original description), pl. 2 (fig. 20); CHAMBERLIN 1924: 171–172, 175, 6 figs. on pp. 171–172; CHAMBERLIN 1930b: 614; CHAMBERLIN 1931: figs. 23A–F, 24B, E, 27E–I; BEIER 1932a: 217 (key), 217–218, fig. 244; BEIER 1952: 238 (key); TAKASHIMA 1955: 176 (listed); WILLIAMS 1971: fig. on p. 9; ROTH AND BROWN 1976: 128, fig. 6.6.

DIAGNOSIS.—Medium to large size (3.89 to 6.90 mm long); color of palps, carapace, sternites, and tergites red-brown; posterior margin of carapace with four to eight setae; posterior tergites granulo-reticulated to pseudosquamose; setae of flagellum with lateral denticles; palps quite stout and strongly granular on all podomeres, more or less uniformly developed throughout; tarsal articulation of legs nearly transverse.

This species is distinct from other species of the *giganteus* group. Its members might be confused with those of *G. giganteus* from which they can be distinguished by their smaller size, robust palps, lower ratio of the lengths of the movable finger of the chela to hand, fewer teeth on the chelal fingers, and granular derm of the legs.

REDESCRIPTION OF THE HOLOTYPE MALE.—Derm of carapace distinctly granular with net-like markings on posterior furrow as in members of *G. giganteus* but not as well developed; posterior margin with four setae.

Abdomen typical; derm of tergites with distinct beaded reticulations on anterior three segments, becoming granulo-reticulated on posterior segments, strongly pseudosquamose with distinct granules on tergite 11; chaetotaxy of tergites 1 to 10: 7:7:9:8:9:10:8:10:12:9± (tergite 10 torn; tergite 12 with 1 [!] seta). Derm of sternites similar to tergites but without granulations on anterior segments; chaetotaxy of sternites 2 to 10: 18:(7)(9)/8:9:10:9:11:10:10:12.

Flagellum of chelicera with three setae, anterior one longest, posterior ones shorter, of approximately the same length, each seta with lateral denticles confined to distal half.

Palp quite stout, strongly granulated on all podomeres. Palpal proportions: trochanter undeterminable, femur 3.3, tibia 2.6, and chela without pedicel 2.9 times as long as broad; movable finger 1.3 times as long as hand.

Chela quite stout; derm coarsely granular on

all surfaces, fingers slightly curved; fixed finger with 64 retroconical teeth, more or less similarly developed throughout; movable finger with 58 retroconical teeth. Chaetotaxy of chela not unusual, *ist* posterior to *isb*, and *est* nearer to *it* than to *isb*; four microsetae near *b*.

Legs typical; derm of most podomeres strongly granular; tarsal articulation transverse as in individuals of *G. giganteus*. Legs not properly mounted for determining proportions.

Measurements (in millimeters): body length 4.19; abdomen 2.97 by 1.91. Carapace: median sclerotized length 1.33, ocular breadth 0.96, posterior breadth 1.49. Chelicera not properly mounted for measuring.

Palp: trochanter length undeterminable by 0.43, femur 1.47 by 0.46, tibia 1.27 by 0.50, chela without pedicel 2.38 by 0.83, hand 1.07 long, movable finger 1.40 long.

Legs not properly mounted for measuring.

Variation of Other Mounted Males.—Data based on nine males from Bahía de los Ángeles, one male from Isla Santa Cruz, five males from Isla San José, five males from Isla del Espíritu Santo, and one male from Isla Cerralvo. Coloration (of other specimens in alcohol): Carapace and pedipalps red-brown; legs white to light tan; coxae red-brown as palps but are lighter; tergites dark dusky brown with tergites 1 to 5 concolorous, tergites 6 to 9 with two non-melanic spots on each tergal half, tergites 10 and 11 lacking spots; sternites similarly dark dusky brown with darker central spot on each half of sternites 5 to 10; pleural membrane buff. Not much deviation from holotype but with these features noted: posterior margin of carapace with four to eight setae. Chaetotaxy of tergites and sternites generally within seven setae of holotype chaetotaxy. Chaetotaxy of sternites 2 and 3: (6–13)(4–12)/7–12. Palpal proportions: trochanter 1.5–1.7, femur 2.9–3.9, tibia 2.6–3.1, and chela without pedicel 2.5–3.3 times as long as broad; movable finger 1.2–1.5 times as long as hand. Three to eight microsetae near tactile hair *b*.

Redescription of the Allotype Female.—Similar to male but larger. Chaetotaxy of genital segments: anterior operculum with 14, posterior operculum with eight setae. Palps not strongly dimorphic except in size. Palpal proportions: trochanter 1.4, femur 3.4, tibia 3.1, and chela without pedicel 2.8 times as long as broad; movable finger 1.4 times as long as hand.

Measurements (in millimeters): body length 5.63; abdomen 4.09 by 2.72. Carapace: median sclerotized length 1.55, ocular breadth 0.98, posterior breadth 1.63. Chelicera not properly mounted for measuring.

Palp: trochanter 0.66 by 0.46, femur 1.53 by 0.45, tibia 1.52 by 0.50, chela without pedicel 2.56 by 0.92, hand 1.14 long, movable finger 1.55 long.

Legs not properly mounted for measuring.

Variation of Other Mounted Females.—Data based on 11 females from Bahía de los Ángeles, five females from Punta Trinidad, five females from Puerto Escondido, 12 females from Isla Danzante, five females from Isla Santa Cruz, five females from Isla San José, five females from Isla del Espíritu Santo, and one female from Isla Cerralvo. Not significantly different from allotype. Variation in chaetotaxy of sternites 2 and 3: 11–23:7–11. Palpal proportions: trochanter 1.4–1.7, femur 2.9–4.0, tibia 2.3–3.2, and chela without pedicel 2.4–3.2 times as long as broad; movable finger 1.1–1.6 times as long as hand.

Type-Data.—The holotype male and allotype female of *Garypus sini* Chamberlin were collected from Puerto Ballandra, Carmen Island, Gulf of California, México, on 21 May 1921 by J. C. Chamberlin. The published date of collection (22 May 1921) is at variance with the date given on the labels. These types are mounted on microscope slides and are deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Quite widespread in the Gulf of California on the islands and adjacent areas of Baja California from Bahía de los Ángeles to Isla Cerralvo. On the Sonoran side, this species is recorded from Bahía de Tepoca to Bahía San Pedro and from a few islands under the jurisdiction of Sonora. Near Bahía San Pedro is Bahía San Carlos where Evans (1968) collected a member of this species from a rock crevice at mid-tide level. The range of this species is from 30°15′N to 24°10′N in the Gulf of California.

Members of this species are the most common pseudoscorpions inhabiting the beaches of Baja California; they can be considered as typical representatives of this habitat. Usually, they are found under rocks in the supralittoral zone, but occasionally they wander into the upper high-tide level, and they are also found under other littoral debris. An ideal habitat for members of

this species would be a gently sloping sandy beach with a well-developed summer berm and with rocks in the supralittoral zone. Occasionally, *G. sini* individuals are found on moderately sloping beaches with pebble-sized stones. Another kind of favorable habitat would be a beach with a rocky front protecting the higher back beach. On Isla del Espíritu Santo near Bahía San Gabriel, the unique population of *G. sini* occurs under rocks surrounding a salt lagoon, which is occasionally deluged by extraordinary high tides such as those that occur with the passing of a "chubasco" (tropical hurricane).

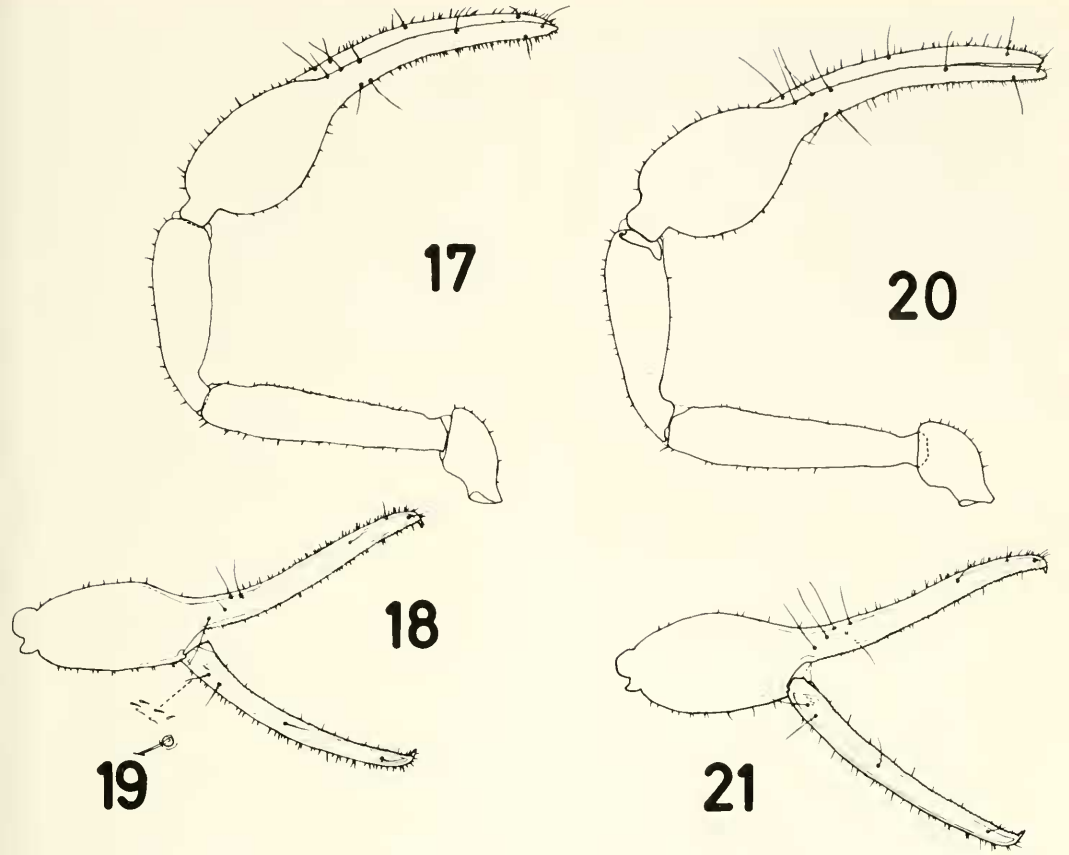
The specimens from Isla San Francisco collected by Lanna Cheng were found under a dead Grebe and in the sand. The latter specimens were extracted by "floatation of the sand" (Cheng, personal communication). The single male near El Requesón was collected from a dead marine mammal (William E. Azevedo, personal communication).

Specimens Examined.—Published records. MÉXICO. *Baja California Sur:* Isla de Carmen, Puerto Balandra, 21 May 1921, J. C. Chamberlin, holotype (CAS Type No. 1268), allotype (CAS Type No. 1269), 2 paratype males (CAS), 26 paratype females (CAS, DRM, UCD), 9 paratype tritonymphs (CAS, UCD), 8 paratype nymphs (CAS), 80 nymphs (CAS); Isla de Carmen, Bahía Marques, 21–22 [23, according to Slevin 1923] May 1921, J. C. Chamberlin, 1 female (UCD); Isla Danzante, Bahía Ballenas, 24 May 1921, J. C. Chamberlin, 1 male, 12 females, 3 nymphs (UCD); Isla Monserrate, N end, 25 May 1921, 1 nymph (CAS); Isla Monserrate, S end, 25 May 1921, J. C. Chamberlin, 2 males, 3 females, 3 protonymphs, 3 nymphs (DRM); Isla Santa Cruz, 11 May [June, according to Slevin 1923] 1921, 3 nymphs (CAS); Isla San José, salt works, J. C. Chamberlin, 1 tritonymph (CAS); Isla Las Galleras, east island, 13 June 1921, 1 female (CAS); Isla del Espíritu Santo, 31 May 1921, J. C. Chamberlin, 1 female, 1 undetermined (DRM); Bahía Agua Verde, 26 May 1921, J. C. Chamberlin, 1 female? (CAS); Bahía Concepción, Bahía Coyote, 18 June 1921, 5 males, 5 females, 1 nymph (CAS). *Baja California Norte:* Isla Coronado (Smiths Island), 27 June 1921, 1 nymph (CAS). *Sonora:* Bahía de Tepoca, 25 Apr. 1921, J. C. Chamberlin, 1 male, 3 females, 2 tritonymphs (CAS, DRM); Isla Tiburón, Indian Village, 5 July 1921, 2 tritonymphs (CAS); Isla San Esteban, 20 Apr. 1921, J. C. Chamberlin, 2 males, 8 females, 1 tritonymph, 3 nymphs (CAS, DRM); Bahía San Pedro, 7 July 1921, 1 female, 14 nymphs (CAS).

New records. MÉXICO. *Baja California Norte:* Bahía de los Ángeles, 15–16 Mar. 1971, V. F. Lee, 51 males, 22 females, 13 tritonymphs, 2 deutonymphs (VFL). *Baja California Sur:* Punta Trinidad (27°48′N, 112°43′W), 20 Mar. 1971, V. F. Lee, 1 male, 6 females, 1 tritonymph (VFL); Santa Rosalía, 27 June 1938, E. S. Ross, A. E. Michelbacher, 2 males, 5 females, 2 tritonymphs (CAS); Bahía Concepción, 25 Oct. 1941, E. S. Ross, G. E. Bohart, 1 male (CAS); Bahía Concepción, 28.4 miles (45.7 km) S of Mulegé, near El Requesón, 26 June 1972, W. E. Azevedo, 1 male (VFL); Bahía Concepción, beach S of Posada Concepción Campground, 7 Apr. 1974, V. F. Lee, 1 male, 1 female (VFL); Bahía Concepción, beach N of Bahía Coyote, 7 Apr. 1974, V. F. Lee, 3 males (VFL); Bahía Concepción, beach N of Bahía Coyote, 8 Apr. 1974, V. F. Lee, 2 males, 1 female (VFL); Bahía Agua Verde (south of Loreto), June 1971, E. S. Ross, 2 males (CAS); Isla de Carmen, Puerto Balandra, 24 May 1970, S. C. Williams, V. F. Lee, 1 male (CAS); Isla Danzante, NW side (bay), 23 May 1970, S. C. Williams, V. F. Lee, 1 female, 1 tritonymph (CAS); Puerto Escondido (17.3 miles [27.8 km] south of Loreto), 27 May 1970, S. C. Williams, V. F. Lee, 13 females, 92 nymphs (CAS); Puerto Escondido, 21 July 1974, R. M. Haradon, W. E. Savary, V. F. Lee, 1 male, 1 tritonymph (VFL); Isla Monserrate, SW end, 23 May 1970, S. C. Williams, V. F. Lee, 1 male, 4 females, 1 nymph (CAS); Isla Santa Cruz, SW end, 25 Mar. 1971, V. F. Lee, 2 males, 12 females, 8 tritonymphs, 1 deutonymph (VFL); Isla San José, near salt works on SE side, 19 May 1970, S. C. Williams, V. F. Lee, 12 females, 11 nymphs (CAS); Isla San José, Bahía Amortajada, Salinas, 25 Mar. 1971, V. F. Lee, 19 males, 4 females, 9 tritonymphs, 2 deutonymphs (VFL); Isla San Francisco, 19 Apr. 1972, L. Cheng, 4 males, 1 female (CAS); Isla San Francisco, SW landing, 7 or 8 Jan. 1976, T. M. Glimme (VFL); Isla del Espíritu Santo, Bahía San Gabriel, 8 July 1968, S. C. Williams, M. M. Bentzien, W. K. Fox, 65 males, 33 females, 55 nymphs (VFL); Isla del Espíritu Santo, SE end at salt lake, 3 Apr. 1976, D. Chivers, W. Lee, 36 males, 10 females, 3 tritonymphs (CAS); Isla del Espíritu Santo, W side, 27 and 28 Mar. 1971, V. F. Lee, 19 males, 43 females, 17 tritonymphs, 2 deutonymphs (VFL); Isla Cerralvo, Piedras Gordas, 17 May 1970, S. C. Williams, V. F. Lee, 3 males, 4 females, 5 nymphs (CAS). *Sonora:* Punta Cirio (29°53′N, 112°40′W), 20 Mar. 1974, V. Roth, W. Brown, 1 deutonymph (VDR); Punta Tepoca (29°18′N, 112°20′W), 22 May 1974, [W.] Brown, Speich, 6 males, 2 females, 3 tritonymphs (VDR); Isla Tiburón, 24 Apr. 1966, K. E. Lucas, 1 deutonymph (CAS); San Carlos, 11 Nov. 1966, W. G. Evans, E. Coan, 1 deutonymph (WGE); Bahía San Carlos, inlet near "Sector Bahía," 14 Apr. 1974, V. F. Lee, 1 male, 60 females, 10 protonymphs (VFL); 15 miles (24 km) S of Guaymas, Apr. 1974, D. Giuliani, 2 females (CAS). *Gulf of California:* (no specific data), 1 male, 1 female, 2 nymphs (DRM, UCD). *No data:* (no specific data), 2 females, 36 nymphs (CAS).

General Bionomics.—The appearance of brooding females on the different islands is dependent on local climatic conditions and on the seasons. During the 1971 expedition, I found only non-brooding females at Bahía de los Ángeles. Nine days later, the embryos of brooding females from Isla Santa Cruz were quite well developed. But on that same day, females from nearby Isla San José had their embryos just extruding from their gonopores. Comparing these areas, the sandy beach at Bahía de los Ángeles was comparatively cool. On Isla Santa Cruz, the beach is sheltered behind a gravelly forebeach and was extremely hot, with little or no breeze. The Isla San José beach is a sandy one peppered with granitic rocks, and cooled by the sea winds.

A study of the sex ratios and brooding females



FIGURES 17 to 21. Figs. 17–19. *Garypus gracilis* Lee, new species, holotype male from Isla Danzante, Baja California Sur, México. Fig. 17. Dorsal view of pedipalp. Fig. 18. Extero-lateral view of chela. Fig. 19. Microsetae near basal tactile seta of movable finger of chela. Figs. 20 and 21. *Garypus gracilis* Lee, new species, allotype female from Isla Danzante, Baja California Sur, México. Fig. 20. Dorsal view of pedipalp. Fig. 21. Extero-lateral view of chela.

indicates that just prior to the mating season, males significantly outnumber females. After mating, the male population decreases in number, and the fertilized females construct brooding nests. By the time the embryos molt into protonymphs, most if not all of the males have disappeared. Brood development begins during March and continues through May or later, depending on the location.

REMARKS.—This widely distributed species consists of isolated populations on a number of beaches in the Gulf. One would, therefore, expect some structural variations among the different populations. For example, the ratio of the length of the movable finger of the chela to the length of the hand shows clinal changes from northern and southern populations in the Gulf. Other trends include: number of setae on tergites and sternites decreases; palps and legs are more slender; size of the appendages increases; and number of microsetae near tactile seta *b* of chelal movable finger increases. But overall, these populations, even the extreme ones, are not significantly different from each other. One probable factor preventing speciation is gene flow by individuals rafted from neighboring beaches.

Garypus gracilis Lee, new species
(Figures 5, 17–21, 30)

DIAGNOSIS.—Medium-size species (4.13 to 4.42 mm long); readily recognized by its light coloration and extremely slender palpal segments; posterior margin of carapace with three to nine setae; pleural membrane bare; setae of

flagellum with lateral denticles; teeth of chela progressively reduced basally; movable finger long, finger 1.4–2.0 times as long as hand; four to eight microsetae near *b*; legs with tarsal articulation nearly transverse.

Members of this species are similar to those of *Garypus sini* from which they can be distinguished by the smaller breadth measurements (hence the overall slenderness) of the palpal podomeres, coloration, and dermal structure of the pedipalps.

Description of the Holotype Male.—Coloration (when in alcohol): Carapace dark dusky brown with small, light patches near furrows; pedipalps light tan with slight reddish tinge, fingers more reddish; legs and coxae whitish or light tan, gnathobases slightly darker; tergal patterning dusky as in members of *G. sini* but of dark tan color, sternites lighter; pleural membrane buff.

Dermal structure of carapace similar to members of *Garypus giganteus*; posterior margin with four setae.

Abdomen typical; derm of anterior tergites granulo-reticulated, becoming reticulate to pseudosquamose on posterior tergites; chaetotaxy of tergites 1 to 10: 8:6:7:10:11:11:14:14:14:15. Sternites with dermal structure similar to *G. giganteus* members; chaetotaxy of sternites 2 to 10: 26:(10)(11)/8:8:8:11:12:14:12:11±.

Flagellum of chelicera with three setae, each seta with a few spinules on apical part.

Palp of unusual slenderness; derm of chela and tibia with coarse granulations, similar to individuals of *G. sini* but derm of femur and trochanter irregularly reticulated. Palpal proportions: trochanter 1.6, femur 4.6, tibia 3.2, and chela without pedicel 4.1 times as long as broad; movable finger 1.7 times as long as hand.

Chela extremely slender; fingers noticeably curved and gaping; fixed finger with 83 retroconical teeth, all similar in shape, basally becoming reduced in height; teeth of movable finger numbering 74 with apical ones retroconical, becoming lowered in height and more posteriorly sloping, the few basal ones retroconical but with rounded apices. Chaetotaxy of chela usual for the genus, with *est* located distal to midpoint of fixed finger, distinctly nearer to *it* than to *isb*, and *st* distinctly nearer to *sb* than to *t*; six microsetae dorsal to tactile seta *b* of movable finger.

Legs of typical form; all podomeres appear pseudosquamose as in *G. giganteus* members; articulation between tarsal segments transverse or nearly so. Leg I proportions: trochanter 1.4, basifemur 3.3, telofemur 2.1, tibia 3.8, metatarsus 2.4, and telotarsus 3.6 times as long as deep. Leg IV proportions: trochanter 2.2, basifemur 1.7, telofemur 3.5, tibia 5.4, metatarsus 2.8, and telotarsus 3.3 times as long as deep.

Measurements (in millimeters): body length 4.13; abdomen 2.84 by 1.95. Carapace: median sclerotized length 1.37, ocular breadth 0.75, posterior breadth 1.27. Chelicera 0.38 long by 0.24 broad.

Palp: trochanter 0.68 by 0.41, femur 1.60 by 0.35, tibia 1.27 by 0.38, chela without pedicel 2.61 by 0.64, hand 0.99 long and 0.58 deep, movable finger 1.68 long.

Leg I: trochanter 0.37 by 0.26, basifemur 0.68 by 0.20, telofemur 0.42 by 0.20, tibia 0.54 by 0.14, metatarsus 0.32 by 0.14, telotarsus 0.34 by 0.10. Leg IV: trochanter 0.56 by 0.26, basifemur 0.41 by 0.24, telofemur 1.01 by 0.29, tibia 0.92 by 0.17, metatarsus 0.40 by 0.14, telotarsus 0.41 by 0.12.

Variation of Mounted Male Paratypes.—Extreme inter- and intra-populational variation. The paratopotype preserved in alcohol differs little from the holotype. One mounted male from Punta Trinidad and one from Isla Monserrate differ from the holotype by: palpal podomeres stouter (trochanter 1.6, femur 3.6–4.0, tibia 3.0, and chela without pedicel 3.4–3.5 times as long as broad; movable finger 1.4–1.5 times as long as hand); slightly smaller appendicular measurements; fewer number of teeth on chelal fingers (76 to 79 on fixed finger, 63 to 66 on movable finger).

Description of the Allotype Female.—Similar to male but larger. These characteristics are noted: chaetotaxy of abdominal sclerites not significantly different from holotype; chaetotaxy of tergites 1 to 10: 7:5:9:8:10:11:11:13:13:12. Chaetotaxy of sternites 2 to 10: 13:6:7:8:11:10:9:11:12. Palp not radically different from holotype. Palpal proportions: trochanter 1.7, femur 4.4, tibia 3.3, and chela without pedicel 3.9 times as long as broad; movable finger 2.0 times as long as hand. Movable finger of chela with five microsetae located near *b*. Leg I proportions: trochanter 1.4, basifemur 3.3, telofemur 2.0, tibia 3.9, metatarsus 3.0, and telotarsus 3.7 times as long as deep. Leg IV proportions: tro-

chanter 2.6, basifemur 1.9, telofemur 3.4, tibia 6.2, metatarsus 3.3, and telotarsus 3.7 times as long as deep.

Measurements (in millimeters): body length 4.87; abdomen 3.40 by 2.06. Carapace: median sclerotized length 1.31, ocular breadth 0.78, posterior breadth 1.19. Chelicera 0.41 long by 0.24 broad.

Palp: trochanter 0.68 by 0.40, femur 1.67 by 0.38, tibia 1.37 by 0.41, chela without pedicel 2.79 by 0.73, hand 0.96 long and 0.63 deep, movable finger 1.88 long.

Leg I: trochanter 0.37 by 0.27, basifemur 0.70 by 0.21, telofemur 0.40 by 0.20, tibia 0.56 by 0.14, metatarsus 0.33 by 0.11, telotarsus 0.38 by 0.10. Leg IV: trochanter 0.65 by 0.25, basifemur 0.44 by 0.24, telofemur 1.05 by 0.31, tibia 0.97 by 0.16, metatarsus 0.42 by 0.13, telotarsus 0.45 by 0.12.

Variation of Mounted Female Paratypes.—Data based on one paratopotype female, one female from Bahía Ballenas on Isla Danzante, one female from Isla Monserrate, five females from Granite Island, and one female from Isla San Luis. Size of paratypes generally exceeds that of allotype. Chaetotaxy of tergites and sternites usually differing from allotype by no more than three or four setae. Genital segments with 13 to 25 setae on anterior operculum, seven to ten on posterior operculum. Palpal proportions: trochanter 1.5–1.9, femur 3.9–4.7, tibia 2.9–3.6, and chela without pedicel 3.4–3.8 times as long as broad; movable finger 1.5–1.8 times as long as hand. Chaetotaxy of chela as in male with the exception that one female from Granite Island has *est* nearer to *isb* than to *it*. Movable finger of chela with four to eight microsetae near tactile hair *b*.

Type-Data and Etymology.—The holotype male, allotype female (both CAS Type No. 11620), one male, four female, and three tritonymph paratypes were collected from: MÉXICO. *Baja California Sur*: Isla Danzante, NW side (bay). The holotype and two female paratypes were collected on 23 May 1970 by S. C. Williams and V. F. Lee. The allotype, one male, one female, and three tritonymph paratypes were collected on 24 May 1970 by the same collectors. The holotype and allotype are mounted on microscope slides and are deposited in the California Academy of Sciences.

This species is named "*gracilis*" for the slenderness of the pedipalps.

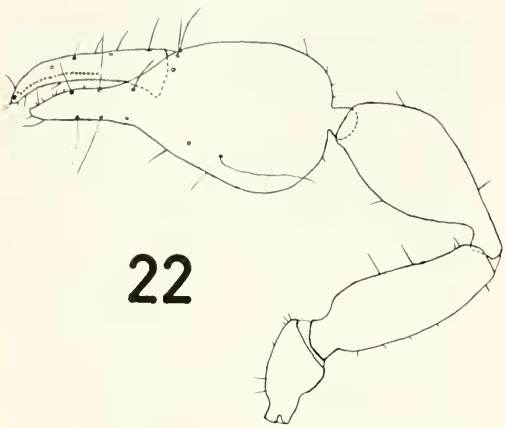
Geographic Distribution and Habitat.—Known from a few islands in the Gulf of California on the Baja California side, from Isla El Muerto to Isla Monserrate and from Punta Trinidad and Bahía Concepción (30°05'N to 25°41'N).

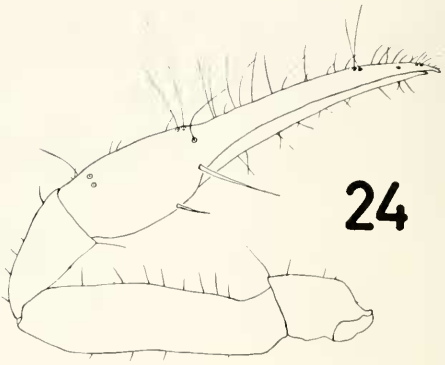
At the type-locality, *Garypus gracilis* individuals were collected from under large rocks in the supralittoral zone, about 0.7 m above the high tide level. Below this zone, the forebeach, composed of a mixture of small pebbles and brown algae, contains a number of marine animals and a unique diurnal scorpion (*Vaejovis* sp.). The combination of gentle wave action, accumulation of algae, and pebble beach is ideal for the many animals that occur there. On the northeastern side of Isla Monserrate, *G. gracilis* individuals were discovered in a similar habitat except that they were found under decaying algae at the high tide level, and the underlying cobblestones were larger. At Punta Trinidad, the unique male was collected from under a rock above a gravelly beach protected from the waves by the adjacent headland.

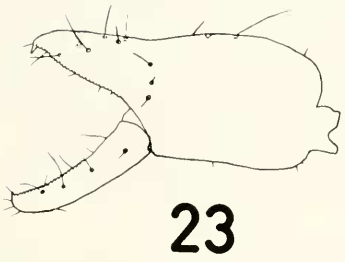
Specimens Examined.—In addition to the specimens listed above from the type-locality, 15 other paratypes were collected from the following eight localities. MÉXICO. *Baja California Norte:* Isla El Muerto (=Miramar), 17 Aug. 1977, J. Nyhan, 2 males (VFL); Isla San Luis, 28 Apr. 1921, J. C. Chamberlin, 2 females (CAS); Granite Island, Puerto Refugio, 2 May 1921, J. C. Chamberlin, 5 females (CAS, DRM, UCD). *Baja California Sur:* Punta Trinidad (27°48'N, 112°43'W), 20 Mar. 1971, V. F. Lee, 1 male (VFL); Bahía Concepción, beach S of Posada Concepción Campground, 7 Apr. 1974, V. F. Lee, 1 male (VFL); Isla de Carmen, Puerto Balandra, 21–22 May 1921, 1 female (CAS); Isla Danzante, Bahía Ballenas, 24 May 1921, J. C. Chamberlin, 1 female (UCD); Isla Monserrate, NE side, 22 May 1970, S. C. Williams, V. F. Lee, 1 male, 1 female (CAS).

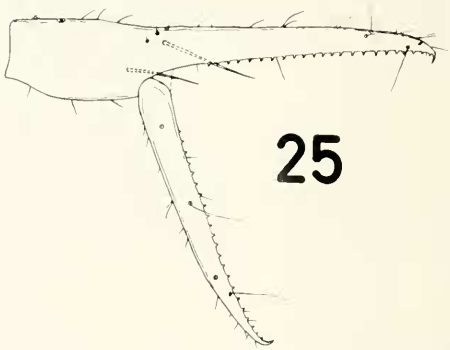
Remarks.—Like *Garypus sini*, members of this new species show intraspecific differences. Most ranges of proportions and measurements in individuals of the two species do overlap with the notable exception of the chelal length-to-breadth ratio. The movable-finger-to-hand-length ratio of individuals of the new species overlaps slightly with individuals of *G. sini* with slender palps. However, identification of members of the two species where they are sympatric is facilitated by the distinctly different palpal proportions, coloration, and palpal dermal structure. Hybrids have not been found in these areas.

To make proper observations of the dermal structure of the palps, one should clear the palps









FIGURES 22 to 25. Figs. 22 and 23. *Menthus lindahli* (Chamberlin), paratype female from Bahía Tepoca, Sonora, México. Fig. 22. Dorsal view of pedipalp. Fig. 23. Extero-lateral view of chela. Figs. 24 and 25. *Paraliochthonius johnstoni* (Chamberlin), female from Isla del Espíritu Santo, Baja California Sur, México. Fig. 24. Dorsal view of pedipalp. Fig. 25. Extero-lateral view of chela.

in a gentle clearing agent, such as clove oil. Harsh agents such as caustic potash can destroy the reticulations of the derm.

Family Menthidae

Genus **Menthus** Chamberlin

Menthus lindahli (Chamberlin)

(Figures 22, 23, 31)

Menthus lindahli: CHAMBERLIN 1930b: 586 (key); BEIER 1932a: 177 (key), 178; ROEWER 1937: 259 (listed); ROTH AND BROWN 1976: 128.

Minniza lindahli CHAMBERLIN, 1923: 365–366 (original description), pl. 2 (fig. 12).

DIAGNOSIS.—Medium-size species (2.66 to 2.87 mm long) of *Menthus*; two eyes present; normal chaetotaxy of tergites 2 to 12: 6:6:6:6:6:6:6:6:T4T:T1T:2; normal chaetotaxy of sternites 5 to 12: 6:6:6:6:6:T4T:TT3TT:2; palps robust, trochanter 1.8–2.0, femur 2.7–3.0, tibia 2.3–2.4, and chela without pedicel 2.0–2.2 times as long as broad; movable finger 0.94–1.0 times as long as hand.

Members of this species can be easily distinguished from those of other known species of *Menthus* of North America by their stout palps, presence of only two eyes whereas members of the other species have four, and less hirsute abdomen.

REDESCRIPTION OF THE HOLOTYPE FEMALE.—Carapace shape as usual for the genus; two weakly corneated but distinct eyes present, posterior pair absent; dermal surface appears smooth, posterior transverse furrow with fine striations; vestitural setae acuminate; anterior margin with four setae, posterior margin with about four.

Abdomen of usual shape; pleural membrane weakly striated; tergal and sternal setae acuminate; complete chaetotaxy of tergites difficult to determine but tergites 7 to 12 observable:

6:6:6:T4T:T1T:2; chaetotaxy of sternites likewise incompletely determinable, anterior and posterior opercula each with nine setae, sternites 4 to 9 with about six setae per segment, sternites 10 to 12: T4T:TT3TT:2.

Chelicera typical; serrula interior destroyed in preparation; serrula exterior with 16 ligulate blades; fixed finger with seven teeth; normal five acuminate setae present on palm of hand; flagellum with four setae, all stout and smooth, anterior seta not observed to have denticles as reported for *Menthus rossi* (Chamberlin) but this may be an artifact of preparation.

Palp robust; derm smooth; vestitural setae sparse, moderately long, and acuminate. Palpal proportions: trochanter 1.8, femur 3.0, tibia 2.4, and chela without pedicel 2.2 times as long as broad; movable finger 1.0 times as long as hand.

Chela stout for genus; fixed finger with more than 25 teeth (basal ones difficult to observe), movable finger with about 21 cuspidate teeth; chelal chaetotaxy typical, with three accessory trichobothria on fixed finger (total on this finger is 11), movable finger with normal set of four trichobothria.

Legs usual; subterminal seta acuminate. Leg I proportions: trochanter undeterminable, basifemur 2.4, telofemur 1.6, tibia 3.4, metatarsus 2.1, and telotarsus 4.3 times as long as deep. Leg IV proportions: trochanter 1.8, basifemur 1.2, telofemur 2.4, tibia 4.5, metatarsus 2.4, and telotarsus 4.1 times as long as deep.

Measurements (in millimeters): body length 2.66; abdomen 2.02 by 0.97. Carapace: median sclerotized length 0.63, ocular breadth 0.31, greatest breadth 0.38. Chelicera not properly mounted for measuring.

Palp: trochanter 0.28 by 0.16, femur 0.47 by 0.16, tibia 0.51 by 0.21, chela without pedicel 0.76 by 0.34, hand 0.39 long, movable finger 0.41 long.

Leg I: trochanter length undeterminable by 0.087, basifemur 0.197 by 0.084, telofemur 0.139 by 0.087, tibia 0.221 by 0.064, metatarsus 0.077 by 0.037, telotarsus 0.136 by 0.031. Leg IV: trochanter 0.179 by 0.097, basifemur 0.134 by 0.111, telofemur 0.343 by 0.144, tibia 0.329 by 0.073, metatarsus 0.106 by 0.044, telotarsus 0.157 by 0.038.

Variation of Mounted Female Paratypes.—Data based on two females from the type-locality. Very similar to holotype, size not appreciably different. Tergite 1 with four setae, tergites 2 to 9 with six, other segments as in holotype. Chaetotaxy of sternites 2 to 4: 11:12–14:8–9, other segments as in holotype. Palpal proportions: trochanter 1.8–2.0, femur 2.7–3.0, tibia 2.3, and chela without pedicel 2.0 times as long as broad; movable finger 0.94–1.0 times as long as hand. Fixed finger of chela with 26 to 30 teeth, movable finger with 21 to 24 teeth.

Type-Data. The holotype female of *Minniza lindahli* Chamberlin was collected from Tepoca Bay, Sonora, México, on 25 April 1921 by J. C. Chamberlin. The holotype is mounted on a microscope slide and is deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Known only from the type-locality, Bahía de Tepoca, Sonora, México (30°15'N, 112°50'W). Chamberlin (1923) reported that members of this species were found under stones along a rocky beach.

Specimens Examined.—Published records. MÉXICO. *Sonora:* Bahía de Tepoca, 25 Apr. 1925, J. C. Chamberlin, holotype (CAS Type No. 1276), 2 paratype females (DRM).

Remarks.—In my collection, I have specimens from arid terrestrial areas in Baja California Norte and in southern California which are probably this species or very closely related to it. Thus, *Menthus lindahli* individuals might be considered as occasional intruders in the beaches.

Family Chthoniidae

Genus **Paraliochthonius** Beier

Paraliochthonius johnstoni (Chamberlin)

(Figures 24, 25, 31)

Chthonius johnstoni Chamberlin, 1923: 357–358 (original description), pl. 2 (fig. 17), pl. 3 (figs. 11–13).
Morikawa [sic] *johnstoni:* Evans 1968: 239.
Morikawia johnstoni: Chamberlin 1962: 312 (key), 312–313, fig. 3A–F; Roth and Brown 1976: 127.
Paraliochthonius johnstoni: Muchmore 1972: 252.
Paraliochthonius mexicanus Muchmore, 1972: 253–254 (original description), figs. 1–5. NEW SYNONYM.
Tyrannochthonius johnstoni: Chamberlin 1929: 74 (key), 75, fig. 2D, F; Chamberlin 1931: 56, fig. 21K; Beier 1932a: 63 (key), 63–64, fig. 78; Roewer 1936: fig. 63III; Roewer 1937: 240 (listed); Wagenaar Hummelinck 1948: 62 (key).
Tyrannochthonius? johnstoni: Hoff 1959: 8.

Diagnosis.—Small species (1.19 to 1.27 mm long); carapacial chaetotaxy d4d–2(18); coxa II with four or five pinnate spines; palp slender, with two guard setae on palm of hand; chela with 21 to 26 acute teeth on fingers, diploid setae near tip of fixed finger.

Female Characteristics.—Data based on three females from Isla del Espíritu Santo. Essentially like the holotype with these features noted. Coloration (of other specimens in alcohol): Typical pallid color for a chthoniid; carapace, chelicera, and pedipalp pale reddish brown; tergites, sternites, and legs lighter; pleural membrane whitish.

Carapacial derm smooth to finely granulated; epistomal process acute, triangular shape, prominent; four eyes, of which the anterior pair is largest, posterior ones smaller; posterior furrow weak, situated very close to posterior margin. Vestitural setae acuminate, chaetotaxy of carapace d4d–2(18), the dwarf setae anterior and ventral to anterior eyes.

Abdomen typical; pleural membrane with granulations appearing beaded; all setae acuminate; derm of tergites transversely striated, terminal segments very finely granulated; all tergites entire; chaetotaxy of tergites: 4:4:5:7:7–8:8–10:7–8:7–8:2P(1–2)P2:4:T2T:0. Derm of sternites 2 to 5 finely granulated, at least the anterior portion of subsequent segments striated; sternites entire except for sternite 3 which is divided, sternite 4 might be partially divided; chaetotaxy of sternites: 10:(3–4)6(3–4):(2)6–7(2):12–14:12:12–13:12:11–12:3P1P3–4:0:2. Each coxa II with four or five pinnate coxal spines, each spine arising from a common base, the interior spine smallest.

Chelicera of usual shape; derm finely granulated except for distinct granules on inner side of palm near base of fixed finger; galeal seta distinctly caudad of finger midpoint; serrula exterior with 16 to 18 blades, blades flat and rectangular shaped, basally fused by less than one-half length of entire structure; serrula interior difficult to count but appears to be more than ten blades; five setae on palm with *is*, *isb*, and *b* roughly in alignment, *es* located near base of movable finger, *as* caudad of *es*; fixed finger with five to seven prominent teeth, reduced in height basally; movable finger with six or seven subequal teeth but smaller than those on fixed finger; flagellum with five or six pinnate setae with distal one short and separate from the others.

Palp moderately slender; derm very finely granulated. Inner face of femur with numerous stout acuminate setae of variable lengths, fewer shorter and finer setae on outer side, tibia with stout setae, more abundant on exterior face. Palpal proportions: trochanter 1.7–1.8, femur 4.0–4.1, tibia 1.9, and chela 4.8–5.2 times as long as broad; movable finger 1.8–2.0 times as long as hand.

Chela of typical shape, moderately slender. Vestitural setae of fingers very fine and slender, longer ones slightly curved, shorter ones more curved, setae of hand tend to be stouter. Fixed and movable fingers each with 22 or 23 homodentate well-spaced teeth, apical and middle teeth acute, basal ones tend to be reduced. Chaetotaxy of chela as described by Chamberlin (1962); two stout guard setae on palm at base of fingers, posterior one about three-quarter length of anterior seta.

Legs moderately slender, derm very finely granulated. Leg IV with tactile setae of tibia 0.33–0.36, of metatarsus 0.20–0.21, and of telotarsus 0.27–0.29 the length of the podomere from the proximal margin. Leg I proportions: trochanter 1.4, basifemur 3.7–4.1, telofemur 2.0–2.1, tibia 2.8–3.0, and tarsus 6.4–6.5 times as long as deep. Leg IV proportions: trochanter 1.5–1.6, basifemur 1.1–1.3, telofemur 1.9–2.1, tibia 4.0–4.1, metatarsus 2.0–2.3, and telotarsus 6.2–6.7 times as long as deep.

Measurements (in millimeters): body length 1.19–1.27; abdomen 0.81–0.88 by 0.45–0.50. Carapace: median sclerotized length 0.32–0.37, ocular breadth 0.39, posterior breadth 0.31–0.33. Chelicera 0.33–0.35 long by 0.16–0.18 broad.

Palp: trochanter 0.16–0.18 by 0.10, femur 0.39–0.41 by 0.10, tibia 0.19–0.21 by 0.10–0.11, chela 0.58–0.63 by 0.12, hand 0.20 long and 0.12 deep, movable finger 0.36–0.40 long.

Leg I: trochanter 0.103–0.110 by 0.073–0.078, basifemur 0.231–0.240 by 0.059–0.063, telofemur 0.099–0.110 by 0.050–0.056, tibia 0.124–0.134 by 0.042–0.047, tarsus 0.223–0.233 by 0.035–0.037. Leg IV: trochanter 0.132–0.144 by 0.087–0.096, basifemur 0.167–0.188 by 0.146–0.150, telofemur 0.268–0.287 by 0.134–0.139, tibia 0.252–0.264 by 0.063–0.064, metatarsus 0.104–0.115 by 0.050–0.052, telotarsus 0.231–0.249 by 0.035–0.038.

Male Characteristics.—Data based on one male from Isla del Espíritu Santo. Very similar to female but slightly smaller. Chaetotaxy as in female, with sternites 1 to 4: 10:[4–4]:5–6/(4±)5–5(4):(1)9(1). Serrula exterior with 12 blades. Palpal proportions: trochanter 1.9, femur 4.0, tibia 1.7, and chela 5.2 times as long as broad; movable finger 2.1 times as long as hand.

TYPE-DATA.—The holotype female of *Chthonius johnstoni* Chamberlin was collected from Arroyo Escondito [sic], elevation 1,600 ft, Puerto Escondido, Baja California, México, on 14 June 1921 by J. C. Chamberlin. As will be discussed below, Chamberlin emended the type-data. The holotype is mounted on a microscope slide and is deposited in the California Academy of Sciences.

GEOGRAPHIC DISTRIBUTION AND HABITAT.—Known from a few localities in the Gulf of California area. Ranges from Bahía Concepción to Pichilingue on the Baja side, and from Bahía Tenacatita, Jalisco (26°44′N to 19°17′N).

Originally reported from Escondido Gorge, near Puerto Escondido at an elevation of about 1,500 [sic] ft (460 m) (Chamberlin 1923), the type-locality was later corrected to Puerto Escondido and the habitat to a littoral one (Chamberlin 1962). All specimens that I collected were from the intertidal zone. On Isla de Carmen, the unique specimen was found under a rock near a mangrove plant on a sandy beach. On Isla del Espíritu Santo, the specimens were collected from under rocks regularly inundated by sea water, between the water line to about a third of a meter above it, at a time when the sea level appeared to be about high low-tide.

SPECIMENS EXAMINED.—Published records. MÉXICO. *Baja California Sur:* Puerto Escondido (emended locality), 14 June 1921, J. C. Chamberlin, holotype (CAS Type No. 1266).

New records. MÉXICO. *Baja California Sur:* Bahía Concepción, beach N of Bahía Coyote, 7 Apr. 1974, V. F. Lee, 3 males (VFL); Bahía Concepción, beach N of Bahía Coyote, 8 Apr. 1974, V. F. Lee, 2 males, 3 females (VFL); Isla de Carmen, Puerto Balandra, 24 May 1970, S. C. Williams, V. F. Lee, 1 male (CAS); Isla del Espíritu Santo, W side, 28 Mar. 1971, V. F. Lee, 6 males, 7 females, 1 nymph (VFL); 1.9 miles (3.1 km) SE of Pichilingue, 11 Apr. 1974, V. F. Lee, 1 male, 1 female (VFL).

REMARKS.—The holotype is not redescribed in this study, since it was adequately done by Chamberlin (1962). However, I note that the tergal and sternal chaetotaxies are: 4:4:5:7:7:7:7:7:7:4:T2T:0 and 9:(3)7(4?):(3)6(3): 10:12:10:10:11:9:0:2, respectively. The female specimens characterized above differ from the holotype in the following ways: the greater chaetotaxic counts of tergites 5 to 9 and of some of the sternites; slight differences in the numbers of serrula exterior blades and teeth of the chelicera; slightly stouter palpal femur and chela; fewer teeth on chela; and the smaller size.

Paraliochthonius mexicanus Muchmore is hereby synonymized with *P. johnstoni* because the diagnostic characters given by Muchmore (1972: 254) are variations I expect in different populations. Also, Muchmore apparently used Chamberlin's erroneous chaetotaxic formulas of *P. johnstoni* in his comparison of the two species.

Family Chernetidae

Genus **Mexachernes** Hoff

Mexachernes carminis (Chamberlin), new combination

(Figures 26, 27, 31)

Chelanops carminis CHAMBERLIN, 1923: 378 (original description), pl. 1 (fig. 10), pl. 3 (figs. 3–5, 27).

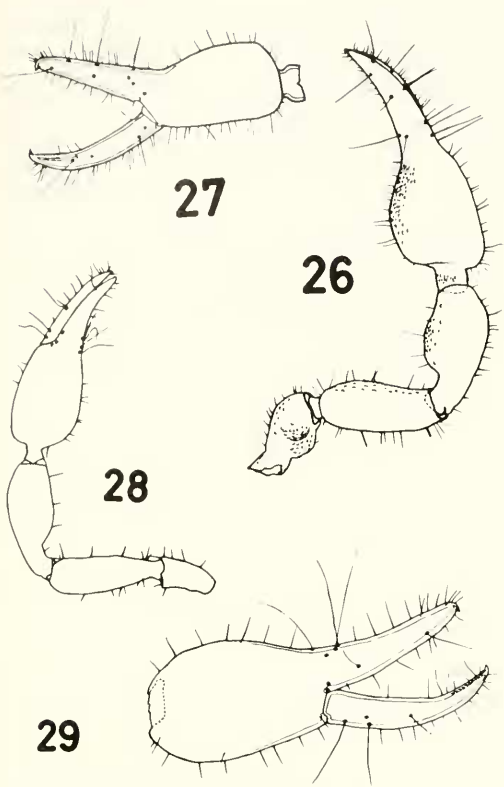
Dinocheirus carminis: ROEWER 1937: 302 (listed); ROTH AND BROWN 1976: 127.

Epaphochernes carminis: BEIER 1932b: 173 (key), 174; BEIER 1933: 537; VACHON 1936: 144, 145.

DIAGNOSIS.—Small species (1.65 to 2.86 mm long); color of carapace, palp, and coxa red-brown; derm of carapace strongly granulated; eyes absent; investing setae of carapace acuminate; pleural membrane distinctly papillate; tergite and sternite 11 each with four pseudotactile setae; setae on cheliceral palm generally acuminate, flagellum with four setae; palp stout, setae mostly acuminate but also few paucidenticulate ones; movable finger of chela 0.88–1.1 times as long as hand; chela without any exterior accessory teeth on both fingers, with three to six interior accessory teeth on fixed finger, one to five on movable finger; tactile seta of leg IV tarsus slightly distal to midpoint of segment.

The nearest relative is the type-species *Mexachernes calidus* (Banks), the only other species in the genus (Hoff 1947). *Mexachernes calidus* individuals are difficult to separate from those of *M. carminis*, but these differences are noted in the former: slightly larger size; less internal accessory teeth on fixed and movable fingers of the pedipalp; less setae on tergites; inner margin of hand of palp slightly more truncate. It is possible that these two species are conspecific, but their habitats are quite distinct. See Remarks for additional discussion.

REDESCRIPTION OF THE HOLOTYPE MALE.—Carapace roughly oval in outline, with posterior margin only slightly convex; length greater than greatest breadth; derm strongly granulated; eyes not present; two distinct transverse furrows, anterior furrow located at about half carapacial



FIGURES 26 to 29. Figs. 26 and 27. *Mexachernes carminis* (Chamberlin), male from Bahía de los Ángeles, Baja California Norte, México. Fig. 26. Dorsal view of pedipalp. Fig. 27. Extero-lateral view of chela. Figs. 28 and 29. *Serianus litoralis* (Chamberlin). Fig. 28. Holotype male from Isla Monserrate, Baja California Sur, México. Dorsal view of pedipalp. Fig. 29. Topotype male. Extero-lateral view of chela (at greater magnification than dorsal view).

length, posterior one about one-fifth length from posterior margin; most vestitural setae denticulate, more or less symmetrically placed; chaetotaxy of carapace 4–8(61).

Abdomen oval shape; pleural membrane strongly papillate; derm of tergites faintly imbricated; tergal and sternal setae acuminate; tergites lightly sclerotized, tergites 1 to 10 divided into distinct tergal halves, tergite 11 entire; chaetotaxy of tergites: 10:10:10:11:11:13:12:11:10:12:PP/P6P:2. Sternal surface finely granulated, sternites 4 to 10 divided, others entire; chaetotaxy of sternites: 22:(3)(2)/25:10:20:22:18:17:14:14:PP/P3±P:2.

Chelicera moderately slender; galea and serrula interior largely destroyed in preparation; galeal seta simple, reaching near apex of galea; serrula exterior with 18 ligulate blades; fixed finger with view of teeth poor; subapical lobe well developed as a blunt tooth of moderate length; five acuminate setae on palm of hand; flagellum probably with four setae, anterior one longest, broad, with anterior serrations confined to apical half, second one slightly shorter and simple, two posterior setae missing.

Palp somewhat stout; derm strongly granulated with coarse granules, especially on exterior and interior surfaces. Vestitural setae numerous, of moderate length, mostly acuminate on exterior faces but setae on interior sides mainly paucidenticulate. Palpal proportions: trochanter 2.0, femur 2.8, tibia 2.2, and chela without pedicel 2.9 times as long as broad; movable finger 1.1 times as long as hand.

Chela of usual shape, moderately stout; several sensory spots scattered about on interior surfaces of both fingers; fixed finger with 41 cuspidate teeth on dental margin, of which the apical one is located between and extero-lateral to dental margin and venedens, no exterior accessory teeth, four interior accessory teeth, large and coarse (unlike other teeth), located well interior to usual marginal teeth; movable finger with 42 marginal teeth, no exterior accessory teeth, four or five interior accessory teeth, form of all teeth similar to those of fixed finger. Chaetotaxy of chela: fixed finger with *eb, esb, ib,* and *isb* basal, *est* and *ist* slightly proximal to midpoint of fixed finger and roughly opposite each other, *et* distal to *it* and near finger tip; movable finger with *b* and *sb* grouped basally, *st* situated slightly distal to midpoint, *t* about one-third movable finger length from venedens, nodus ramosus located slightly posterior to *t*.

Legs of typical chernetine facies; derm of all podomeres finely granulated. Legs I and IV moderately hirsute on all surfaces, all setae acuminate and of moderate length. Subterminal seta long and acuminate. Slit sensillum (="sense dome") of tarsus of leg IV near proximal margin of podomere. Tactile seta of leg IV tarsus slightly distal to midpoint of the segment (1/L [of Vachon 1936]=0.58). Leg I proportions: trochanter 1.4, basifemur 1.6, telofemur 2.8, tibia 3.5, and tarsus 4.6 times as long as deep. Leg IV proportions: trochanter 1.7, basifemur 1.4, telofemur 2.9, tibia 4.9, and tarsus 4.6 times as long as deep.

Measurements (in millimeters): body length 1.65; abdomen 1.05 by 0.71. Carapace: median

sclerotized length 0.61, greatest breadth 0.48. Chelicera not properly mounted for measuring.

Palp: trochanter 0.34 by 0.17, femur 0.53 by 0.19, tibia 0.50 by 0.22, chela without pedicel 0.90 by 0.31, hand 0.45 long, movable finger 0.51 long.

Leg I: trochanter 0.11 by 0.08, basifemur 0.16 by 0.10, telofemur 0.27 by 0.09, tibia 0.24 by 0.07, and tarsus 0.26 by 0.06. Leg IV: trochanter 0.21 by 0.13, basifemur 0.17 by 0.12, telofemur 0.34 by 0.12, tibia 0.38 by 0.08, and tarsus 0.31 by 0.07.

Variation of Other Mounted Males.—Data based on one male from Bahía de los Ángeles, one male from Isla Danzante, two males from Isla Monserrate, and five males from Isla del Espíritu Santo. Inter-populational variation pattern reminiscent of that for *Garypus sini*. Coloration (of other specimens in alcohol): Carapace, palps, and coxal area reddish brown, in contrast to yellowish tan of tergal and sternal halves, and legs; pleural membrane white. Carapacial chaetotaxy: anterior margin with four or five, posterior margin with seven or eight setae, total number of carapacial setae 67 to 84. Tergal and sternal chaetotaxy usually not more than three setae difference from holotype chaetotaxy, pseudotactile setae not at variance with holotype. Chaetotaxy of sternites 2 and 3: 26–31:(2–3)(1–3)/23–30. Chelicera with four to six simple galeal rami, usually placed unilaterally but may be branched bilaterally; serrula exterior with 14 to 19 blades; serrula interior with 14 or 15 blades, normally developed for a chernetid; fixed finger with five or six teeth, distal ones small, located on apical tooth, proximal ones larger; setae of flagellum as in holotype, with the two posterior setae simple, about half the length of the others. Palpal proportions: trochanter 1.8–2.1, femur 2.6–3.0, tibia 2.1–2.5, and chela without pedicel 2.3–3.2 times as long as broad; movable finger 1.0–1.1 times as long as hand. Chela as in holotype; both movable and fixed fingers with 41 to 47 marginal teeth, three to six interior accessory teeth on fixed finger, and two to five on movable finger. Tactile seta of leg IV tarsus located at 0.52–0.59 length of segment. Leg I proportions: trochanter 1.2–1.3, basifemur 1.5–1.7, telofemur 2.6–2.9, tibia 3.1–3.8, and tarsus 4.3–5.3 times as long as deep. Leg IV proportions: trochanter 1.7–2.2, basifemur 1.4–1.8, telofemur 2.8–3.1, tibia 4.0–4.8, and tarsus 3.8–5.3 times as long as deep.

Redescription of the Allotype Female.—Similar to male but larger. Most chaetotaxic and dental counts come within range of males. Distinctive characteristics worth noting are: anterior operculum with 23 setae, posterior operculum with 14 setae. Palpal proportions: trochanter 1.9, femur 2.8, tibia 2.3, and chela without pedicel 2.8 times as long as broad; movable finger 1.1 times as long as hand.

Measurements (in millimeters): body length 2.20; abdomen 1.56 by 1.02. Carapace: median sclerotized length 0.65, greatest breadth distorted. Chelicera length undeterminable by 0.13 broad.

Palp: trochanter 0.34 by 0.18, femur 0.56 by 0.20, tibia 0.52 by 0.23, chela without pedicel 0.99 by 0.35, hand 0.49 long, movable finger 0.55 long.

Leg I: trochanter 0.13 by 0.10, basifemur 0.18 by 0.11, telofemur 0.30 by 0.10, tibia 0.27 by 0.08, tarsus 0.29 by 0.06. Leg IV: trochanter 0.24 by 0.14, basifemur 0.19 by 0.13, telofemur 0.39 by 0.14, tibia 0.43 by 0.09, tarsus 0.34 by 0.07.

Variation of Other Mounted Females.—Data based on five females from Isla Monserrate and one female from Isla del Espíritu Santo. Not much different from the allotype, with these features noted: anterior operculum with 18 to 29 setae, posterior operculum with ten to 15 setae. Palpal proportions: trochanter 1.5–2.0, femur 2.5–2.7, tibia 2.0–2.5, and chela without pedicel 2.7–3.0 times as long as broad; movable finger 0.88–1.1 times as long as hand.

Type-Data.—The holotype male and allotype female of *Chelanops carminis* Chamberlin were collected from Puerto Ballandra, Carmen Island, Gulf of California, México, on 21 May 1921 by J. C. Chamberlin. The published date of collection (22 May 1921) differs from that given on the labels. These types are mounted on microscope slides and are deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Known from a few localities in the Gulf of California, from Bahía de los Ángeles to Isla del Espíritu Santo, Baja California, and from Isla Pelicano, Sonora. A female was collected at Isla San Luis from drifted seaweed (Chamberlin 1923). The range of this species is from 29°58′N to 24°30′N.

Members of this species are found in similar environmental conditions as *Paraliochthonius*

johnstoni, but in the upper parts of the zone occupied by members of the latter species. They inhabit the upper littoral zone, which is regularly covered by sea water. On rare occasions, individuals may be found as high as the supralittoral zone, where they are in sympatry with members of the species of the genus *Garypus*. The kind of beach favorable for the occurrence of individuals of this species is a moderately sloping one with gentle wave action. On the inlet beach at Isla del Espíritu Santo, individuals are found on the undersides of gravelly rocks on a coral-laceous-sandy beach. The type-specimens were collected in company with members of *Garypus sini* and *Menthus rossi* from under stones and debris along a rocky beach.

Specimens Examined.—Published record. MÉXICO. *Baja California Sur:* Isla de Carmen, Puerto Balandra, 21 May 1921, J. C. Chamberlin, holotype (CAS Type No. 1294), allotype (CAS Type No. 1295).

New records. MÉXICO. *Baja California Norte:* Bahía de los Ángeles, 15 or 16 Mar. 1971, V. F. Lee, 1 male (VFL). *Baja California Sur:* Bahía Concepción, beach N of Bahía Coyote, 7 Apr. 1974, V. F. Lee, 4 males (VFL); Bahía Concepción, beach N of Bahía Coyote, 8 Apr. 1974, V. F. Lee, 2 males, 4 females (VFL); Isla de Carmen, 21 May 1921, [J. C. Chamberlin, probably], 2 males (unpublished paratypes) (CAS); Isla Monserrate, NE end, 22 May 1970, S. C. Williams, V. F. Lee, 2 males, 7 females (CAS); Isla Monserrate, SW end, 23 May 1970, S. C. Williams, V. F. Lee, 1 male, 2 females (CAS); Isla Danzante, NW side (bay), 24 May 1970, S. C. Williams, V. F. Lee, 1 male (CAS); Isla del Espíritu Santo, W side, 28 Mar. 1971, V. F. Lee, 8 males, 2 females, 3 tritonymphs, 1 deutonymph (VFL). *Sonora:* Isla Pelicano, 27 Jan. 1973, [V. D.] Roth, [W.] Brown, 1 male, 2 females (WBM).

Remarks.—Previous authors, without studying the types of *Chelanops carminis*, have placed this species in various genera. It is here combined with *Mexachernes* Hoff, on the advice of William B. Muchmore, who has studied the lectotype of *M. calidus* and has shared his data sheet with me. It is his conclusion and mine that *M. carminis* is congeneric with *M. calidus*.

As alluded to in the diagnosis, *M. calidus* is structurally very similar to *M. carminis*. Muchmore has suggested that these two species might be synonymous (personal communication). However, the type-specimens of *M. calidus* were apparently collected from San Miguel de Horcasitas, Sonora, México, a terrestrial locality. But all records of *M. carminis* are from littoral habitats. If these two species are indeed synonymous, I would suggest that the locality data for *M. calidus* is in error, since I find it hard to believe that one species would be found in such dissimilar habitats.

Family Olpiidae

Genus **Serianus** Chamberlin

Serianus litoralis (Chamberlin)

(Figures 28, 29, 31)

Garypinus litoralis Chamberlin, 1923: 368 (original description), pl. 1 (fig. 4), pl. 2 (fig. 4).

Serianus litoralis: Chamberlin 1930b: 595 (key); Beier 1932a: 211 (key), 212; Roewer 1937: 265 (listed); Feio 1945: 17 (key); Roth and Brown 1976: 129.

Diagnosis.—Small species (2.26 to 2.60 mm long); most sclerotized parts of dusky-black or red-brown color; chaetotaxy of carapace 4–2(20); chaetotaxy of abdomen fairly constant, tergite 10 with four tactile setae, tergite 11 with two, sternites 10 and 11 each with four; palps moderately stout, chela without pedicel 2.9 times as long as broad; movable finger 0.88–1.0 times as long as hand; chela with 29 teeth on fixed, 24 on movable finger.

Redescription of the Holotype Male.—Coloration (on slide): Carapace dusky black; pedipalp reddish brown, hand dusky black; legs whitish; tergites and terminal sternites light dusky black.

Carapace roughly oval in shape; length longer than greatest breadth; anterior margin truncated; derm smooth but appears lightly wrinkled under transmitted light; four well-developed eyes, anterior pair located one-half ocular diameter from anterior carapacial margin and slightly larger than posterior pair; four setae near anterior margin, one near each posterior eye, others symmetrically placed on carapace, two setae near posterior margin, chaetotaxy of carapace 4–2(20).

Abdomen of typical shape; pleural membrane longitudinally wrinkled; surface of tergites superficially smooth but under high magnification extremely finely granulated; tergite 1 lightly sclerotized (might be feebly divided), tergites 2 to 5 medially divided, of which 4 and 5 might be interpreted as only partially divided, tergites 6 to 10 with median notch on anterior margin of each tergite, tergite 11 not divided; chaetotaxy of tergites: 5:4:4:4:4:6:6:6:6:T2T2T2T:T5T:2; derm of sternites as in tergites, sternite 2 entire, sternites 5 to 10 with median notch on anterior margin, sternite 11 entire; chaetotaxy of sternites: 8:(2)(2)/5:8:8:8:8:8:6:T2T3T2T:TT6TT:2.

Chelicera usual as defined for genus; serrula exterior with about 16 to 19 blades; subapical lobe moderately well developed; five acuminate setae on palm; flagellum with four slender setae, anterior three long, of approximately the same length, posterior seta half the length of the others.

Palp of typical generic shape, relatively stout, all surfaces smooth. Palpal proportions: trochanter 1.8, femur 3.1, tibia 2.4, and chela without pedicel 2.9 times as long as broad; movable finger 0.96 times as long as hand.

Chela of typical generic facies, hand roughly ovate in both dorsal and lateral views; teeth of fixed and movable fingers largely destroyed; chaetotaxy of chela typical for genus.

Legs of typical structure; derm essentially smooth; all legs relatively stout; setation sparse, consisting of slender acuminate setae; pseudotactile seta of leg IV tibia removed from basal margin by 0.29 length of podomere, of metatarsus by 0.19. Leg I proportions: trochanter 1.3, basifemur 1.2, telofemur 1.8, tibia 3.5, metatarsus 2.0, and telotarsus 3.0 times as long as deep. Leg IV proportions: trochanter 1.3, basifemur 1.3, telofemur 2.2, tibia 3.3, metatarsus 1.9, and telotarsus 3.0 times as long as deep.

Measurements (in millimeters): body length 2.60; abdomen 1.95 by 0.82. Carapace: median sclerotized length 0.63, ocular breadth 0.36, greatest breadth 0.52. Chelicera 0.18 long by 0.14 broad.

Palp: trochanter 0.29 by 0.16, femur 0.56 by 0.18, tibia 0.55 by 0.23, chela without pedicel 0.95 by 0.33, hand 0.51 long, movable finger 0.49 long.

Leg I: trochanter 0.10 by 0.08, basifemur 0.13 by 0.11, telofemur 0.22 by 0.12, tibia 0.26 by 0.07, metatarsus 0.09 by 0.05, telotarsus 0.12 by 0.04. Leg IV: trochanter 0.18 by 0.14, basifemur 0.18 by 0.14, telofemur 0.44 by 0.20, tibia 0.38 by 0.11, metatarsus 0.12 by 0.06, telotarsus 0.18 by 0.06.

Variation of Other Mounted Males.—Data based on male specimens listed below except for the holotype. Practically identical with holotype with these exceptions and additional data. Holotype a little larger than other males. Chaetotaxy of carapace, tergites, and sternites similar with few minor deviations. Serrula interior with ten blades; anterior seta of flagellum of topotype with simple short branch near apex. Chelal movable finger 0.88–1.0 times as long as hand; fixed finger of chela with about 29 obtusely retroconical teeth, movable finger of Mazatlán male with 24 teeth, apical eight retroconical, posterior ones low and long, not acute. Location of pseudotactile setae of leg IV: on tibia, 0.36–0.37 and on metatarsus, 0.22 length of podomere from basal margin.

Type-Data.—The holotype male of *Garypinus litoralis* Chamberlin was collected from the south end of Monserrate Island, Gulf of California, México, on 25 May 1921 by J. C. Chamberlin. The holotype is mounted on a microscope slide and is deposited in the California Academy of Sciences.

Geographic Distribution and Habitat.—Known from only two localities in México, Isla Monserrate and Mazatlán (25°41′N to 23°13′N).

At Isla Monserrate, individuals of this species were found under shark skeletal fragments and turtle shells in the supralittoral zone near an abandoned hut used by fishing persons. In the same locality, the holotype was collected from under stones on a beach (Chamberlin 1923).

Specimens Examined.—Published records. MÉXICO. *Baja California Sur:* Isla Monserrate, S end, 25 May 1921, J. C. Chamberlin, holotype (CAS Type No. 1283). *Sonora:* near Mazatlán, July 1926, G. F. Ferris, 1 male (DRM).

New record. MÉXICO. *Baja California Sur:* Isla Monserrate, SW end, 23 May 1970, S. C. Williams, V. F. Lee, 1 male, 1 female, 1 tritonymph (CAS).

Remarks.—It is notable that members of this species have only been found in the supralittoral zone and that those of the other species of *Serianus* are almost always strictly terrestrial or only occasionally found near the seashore. The specimens studied show remarkably low variation for individuals taken from localities over 560 km apart.

Key to the Species of Maritime Pseudoscorpions of Baja California

1a. Tarsus of first leg with one segment, tarsus of fourth leg subdivided to form two segments; chelal fingers without venom apparatus ..... *Paraliochthonius johnstoni* (Chamberlin)

1b. Tarsi of all legs similar; venom apparatus usually present in at least one chelal finger 2

2a. Tarsi of all legs not divided ..... *Mexachernes carminis* (Chamberlin)

2b. Tarsi of all legs divided 3

3a. Venom apparatus only in fixed chelal finger; movable chelal finger with a receptor venedens ..... *Menthus lindahli* (Chamberlin)

3b. Venom apparatus in both chelal fingers, no receptor venedens 4

4a. Pleural membrane smoothly and evenly plicate; coxal area not widened posteriorly; investing setae of palps generally prominent, slender and acute ..... *Serianus litoralis* (Chamberlin)

4b. Pleural membrane wrinkled plicate; coxal area widened posteriorly; investing setae of palps short and inconspicuous 5

5a. Tarsal articulation strongly oblique (Fig. 4); setae of flagellum on most individuals acute (Fig. 2), few individuals with apical branching; microsetae not present dorsal to tactile seta *b* of movable finger of chela; pleural membrane, especially the terminal segments, with investing setae (Fig. 6) 6

5b. Tarsal articulation transverse, or nearly so (Fig. 5); setae of flagellum with lateral spinules (Fig. 3); at least one microseta associated with *b* of movable chelal finger (Fig. 19); pleural membrane bare 7

6a. Palp extremely attenuated, femur 5.3, chela without pedicel 3.9 times as long as broad; movable chelal finger 1.8 times as long as hand ..... *Garypus guadalupensis* Chamberlin

6b. Palp moderately slender, femur 3.6–4.8, chela without pedicel 2.9–3.7 times as long as broad; movable chelal finger 1.2–1.4 times as long as hand ..... *Garypus californicus* Banks

7a. Small size, median sclerotized length of carapace less than 1.2 mm; derm of chela imbricated; one or two microsetae near *b* of movable chelal finger; length of movable chelal finger at most 1.1 times length of hand ..... *Garypus pallidus* Chamberlin

7b. Larger size, carapacial length more than 1.2 mm; derm of chela granulated; most individuals with more than two microsetae near *b* of movable chelal finger; most individuals with length of movable chelal finger over 1.1 times longer than hand 8

8a. Derm of at least the chelal femur and trochanter irregularly reticulated; movable chelal finger of male 1.4–1.7, of female 1.5–2.0 times as long as hand ..... *Garypus gracilis* Lee, new species

8b. Derm of all segments of palps granulated, more or less equally developed throughout; movable chelal finger of male up to 1.5, of female up to 1.6 times as long as hand 9

9a. Chela fairly stout, chela without pedicel of male 2.5–3.3, of female 2.4–3.2 times as long as broad ..... *Garypus sini* Chamberlin

9b. Chela more slender, chela without pedicel of male 3.4–3.9, of female 3.1–3.6 times as long as broad ..... *Garypus giganteus* Chamberlin

Natural History, Faunal Origins, and Affinities

Habitat Preference

As a rule, pseudoscorpions are cryptic animals. They are found in microhabitats where they can avoid direct sunlight. In littoral areas, they live under rocks and littoral debris such as driftwood, wrack (dead, decaying seaweed), and fish bones, and within rock crevices (lithoclases). In Baja California, most of these habitats have been investigated with the exception of lithoclases.

Most pseudoscorpions, especially supralittoral forms such as members of *Garypus* species, are found under rocks where temperatures are cooler than those of sun-exposed surfaces. Normally, they are active at night, though sometimes, individuals can be seen crawling about on open sand during the day. These pseudoscorpions are probably seeking shelter. In general, activities of pseudoscorpions would, of course, be limited to only those seasons when they have not yet constructed nests for hibernation, brooding, or molting.

Wrack accumulations are especially abundant on sandy and cobblestone beaches of the northern and central Pacific coast of Baja California. These extensive banks consist mainly of marine algae; but occasionally, surfgrass of the family Zosteraceae is the dominant element. Within these accumulations is a community of marine crustaceans (mostly isopods and amphipods), insects, and bacteria, which breaks down this rich organic matter. Predaceous insects, cen-

tipedes, and arachnids, including *Garypus* pseudoscorpions, venture into the wrack to feed on this assemblage of prey.

Pseudoscorpions are less likely to be found under other kinds of littoral detritus. These microhabitats are not as well insulated, abundant, nor as permanent as are rocks, but they do afford some protection. On Isla Monserrate, members of *Serianus litoralis* are unique in that they occur under shark carcasses that can get quite hot in direct sunlight. This species, however, belongs to a genus other members of which characteristically live in xeric terrestrial areas.

Supralittoral pseudoscorpions are infrequently reported from lithoclases. On the mainland side of the Gulf of California, Evans (1968) found a specimen of *Garypus sini* in a crevice of intertidal rocks at Bahía San Carlos, Sonora. However, species whose members are truly intertidal, such as *Halobisium occidentalis* Beier in California, are abundantly represented in this habitat. *H. occidentalis* members have been commonly found in the intertidal zone of rocky beaches and in salt marshes (Schulte 1976; personal notes).

A favorable type of beach for finding members of the two truly intertidal species, *Mexachernes carminis* and *Paraliochthonius johnstoni*, consists of small, pebble-sized rocks, interspersed with dead or dying algae, and is subjected to gentle wave action. On such a beach, these pseudoscorpions crawl among the rocks in search of prey and are periodically immersed in sea water. Individuals are sometimes found on sandy beaches that are generally devoid of any vegetation and are spotted with only a few rocks. However, they appear to be pioneers on such beaches, and it is likely that they will be unsuccessful in establishing themselves.

Ecological Role

All pseudoscorpions are predaceous. They feed on any live microarthropods that they can handle. In the laboratory, they have been observed to feed on both live and freshly killed insects, arachnids, and other invertebrates. As a group, pseudoscorpions are important as small carnivores within cryptozoan communities.

Maritime pseudoscorpions can be an important element in beach communities. They may outnumber all other predators, particularly in microhabitats under rocks in the supralittoral zone of beaches in the Gulf of California. As an extreme example, *Garypus sini* individuals are practically the only predators under rocks on the shore of a hypersaline lake on Isla del Espíritu Santo (S. C. Williams, Welton L. Lee, Dustin D. Chivers—personal communications). But in the littoral zones of most other types of beaches, pseudoscorpions are less abundant, and therefore, serve only a minor role as predators.

Maritime pseudoscorpions play a less important role in wrack accumulations than under rocks. Since wrack is relatively transient and rich in organic matter, it is a temporary ecosystem well exploited by small animals. Scavengers, herbivores, and carnivores in succession decompose and recycle this accumulation of dying algae and marine plants. The pseudoscorpion element in wrack is quite small in numbers of individuals and in species diversity, as Backlund (1945) has shown in a study of Scandinavian wrack. On the beaches of the Gulf of California, one can usually find occasional individuals of the intertidal species *Mexachernes carminis* and *Paraliochthonius johnstoni*, but rarely those of supralittoral species. In contrast, members of the supralittoral species *Garypus californicus* and *G. giganteus* are found in far greater abundance in wrack on the Pacific coast of Baja California. However, intertidal species have yet to be reported from there. The Pacific side of Baja, as discussed above, has greater wrack accumulations than the beaches on the Gulf side.

Spiders occupy a similar niche as that of the pseudoscorpions. Most spiders inhabiting the supralittoral zone of sandy or cobblestone beaches are eurycoenic species; others are only transients. Although spiders are more diverse than pseudoscorpions, they are not as abundant nor as habitat restricted. However, recent investigations of the littoral zone of rocky intertidal beaches of the Gulf reveal a great variety of spiders that appears to be highly restricted to this habitat (Roth and Brown 1976).

Species Diversity and Geographical Comparisons

There is no other area in the world of comparable size known to have such a diverse supralittoral and littoral pseudoscorpion fauna as the coastline of Baja California and the associated islands (see Table 1). The maritime pseudoscorpion fauna of Baja California includes nine species belonging to four genera of

TABLE 1. COMPARISON OF THE SPECIES DIVERSITY OF MARITIME PSEUDOSCORPIONS OF SELECTED AREAS. Genera present by region (number of species in parentheses).

Family	Baja California	western U.S.–Canada	eastern U.S.	Europe*
Chthoniidae	*Paraliochthonius* (1)		*Paraliochthonius* (1) *Chthonius* (1)	*Paraliochthonius* (2) *Chthonius* (1) *Neochthonius* (1)
Neobisiidae		*Halobisium* (1) *Parobisium* (1)		*Neobisium* (1)
Garypidae	*Garypus* (6)	*Garypus* (1)	*Garypus* (1)	*Garypus* (3)
Olpiidae	*Serianus* (1)		*Serianus* (1)	
Chernetidae	*Mexachernes* (1)	*Mucrochernes* (1)	*Epactiochernes* (2) *Parachernes* (1)	*Pselaphochernes* (1)
Total number of species	9	4	7	9

* Data mostly taken from Beier (1963). *Olpium pallipes* (Lucas) of the Olpiidae is excluded since it is probably a transient.

four families. (I exclude from this number *Menthus lindahli*, members of which are not restricted to beaches.) In contrast, there are only four species in four genera belonging to three families represented along the entire United States and Canadian Pacific seacoasts. The east coast fauna of the United States is reported to include seven species in six genera, placed in four families; and the European fauna include nine maritime species belonging to six genera of four families.

The pseudoscorpion families that are represented on the east coast of the United States also have members on the Baja coast. Also, it is interesting to note that representatives of three genera on the former coast have ecological (if not also congeneric) counterparts in Baja California (Table 1). Members of *Paraliochthonius weygoldti* Muchmore from Florida inhabit the intertidal zone as do members of *P. johnstoni*. Members of *Garypus floridensis* Banks are probably supralittoral in habitat preference, as are members of six species of *Garypus* of Baja California. *Epactiochernes tumidus* (Banks) individuals occur below the normal high-tide level on a beach in North Carolina, and are thus regularly submerged by sea water (Weygoldt 1969). Members of *Mexachernes carminis* in the Gulf of California are found in the same habitat. *Serianus carolinensis* Muchmore individuals are found on the same beach as those of *E. tumidus*, but they occur higher in the sand dunes, well above the supralittoral zone (Weygoldt 1969). In contrast, *S. litoralis* members in the Gulf are found only in the supralittoral zone.

Three of the four pseudoscorpion families represented on European coasts also have members on the west coasts of Canada and the United States. Chthoniids have been reported from the European coast but not from the west coasts of Canada and the United States. I have excluded a record of *Apochthonius occidentalis* Chamberlin from the Oregon coast (Schulte 1976) on the grounds that members of this species normally inhabit leaf litter of forests.

The distinction between the Baja California–east coast United States pseudoscorpion fauna and the west coast United States–European fauna reflects the origins of the faunas. The Olpiidae are a tropical group that have penetrated into deserts and other arid areas of the Nearctic and Palaearctic regions. The Neobisiidae are a family characteristic of the Holarctic region.

Sympatry

On any beach in Baja California inhabited by pseudoscorpions, one can usually find representatives of at least two species (Tables 2 and 3). Members of four species were found on a beach at Isla del Espíritu Santo: *Garypus sini*, *Mexachernes carminis*, *Paraliochthonius johnstoni*, and *Menthus rossi* (Chamberlin); those of the latter are transients. Members of two species of *Garypus* coexist on the same beach in several instances. For example, on the Pacific side of Baja, *G. giganteus* and *G. californicus* individuals occur sympatrically near Miller's Landing, Laguna Manuela, and on Isla Asunción. Members of both *G. guadalupensis* and *G. califor-*

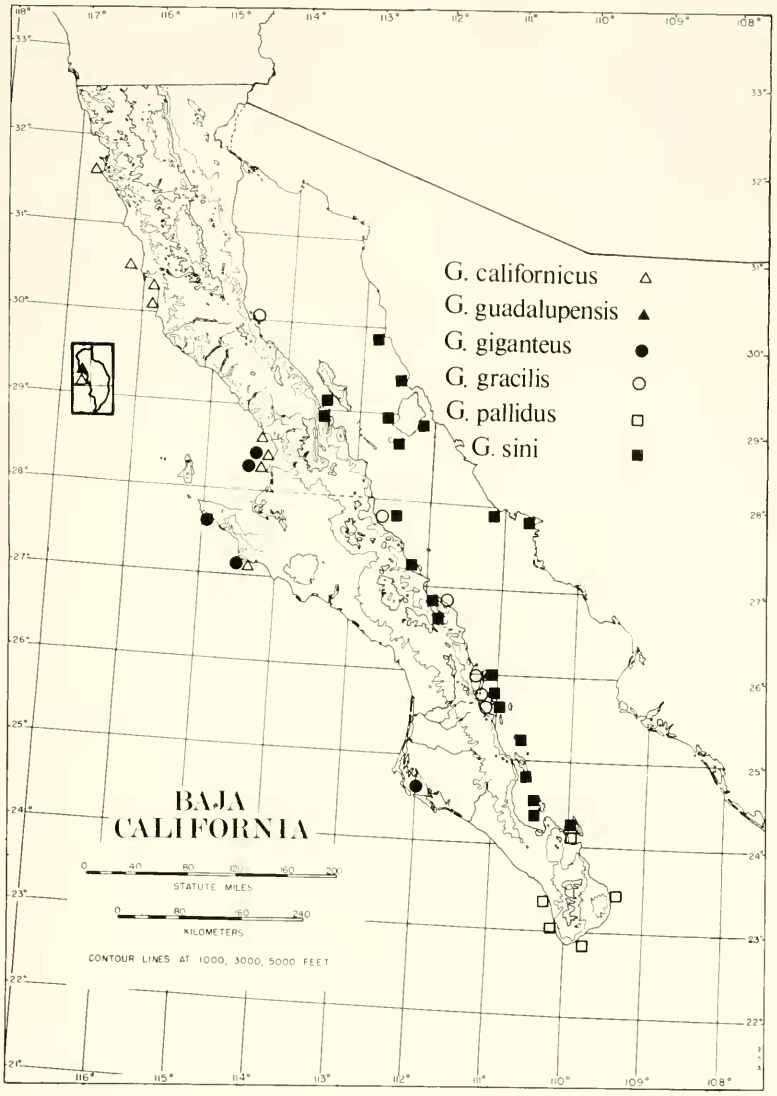


FIGURE 30. Geographic distribution of the Baja California species of *Garypus*.

nicus have been found on Isla de Guadalupe. In the Gulf, *G. sini* and *G. pallidus* members have both been found at Isla Cerralvo. However, in this instance, the collections were made at different times: Only *G. pallidus* members were found by Chamberlin in 1921, and by Banks and Farmer in 1962, while only *G. sini* members were found by Williams and Lee in 1970. It is possible that samples were taken from different habitats, and therefore, these two species are ecologically isolated.

Oddly enough, although macrosympatry can be demonstrated, there is evidence that microsympatry does not occur. For example, members of *Garypus gracilis* were collected with those of *G. sini* at Isla de Carmen, Isla Danzante, Isla Monserrate, and Punta Trinidad. However, such occurrences are not so intimate as these collections might suggest. At Punta Trinidad, an individual of *G. gracilis* was found on the south side of a small promontory, while a larger number of *G. sini* individuals were found on the north side. At Bahía Concepción, allotopy of sympatric species is even more pro-

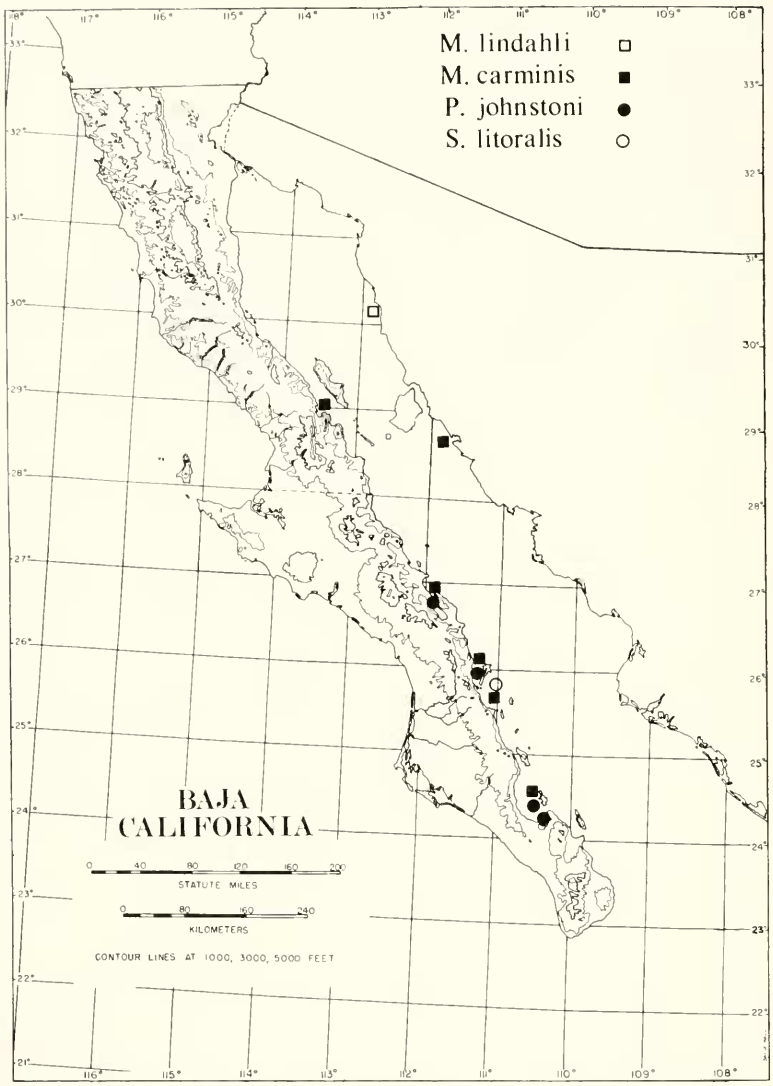


FIGURE 31. Geographic distribution of *Menthus lindahli* (Chamberlin), *Mexachernes carminis* (Chamberlin), *Paraliochthonius johnstoni* (Chamberlin), and *Serianus litoralis* (Chamberlin).

nounced. A specimen of *G. gracilis* was collected under a rock within a meter of another rock under which two specimens of *G. sini* were found. The two rocks were at the same horizontal level; the ecological conditions appeared to be identical.

The respective mean sizes of members of the four species represented on Isla del Espíritu Santo are significantly different. The different sizes indirectly suggest different food requirements (i.e., assortative feeding). Weygoldt (1969) cited a few examples of the food preferences of pseudoscorpions: Chthoniids prefer collembolans while chernetids seem to prefer small flies, psocopterans, and adult and larval beetles. *Garypus californicus* members feed on hard-bodied as well as soft-bodied arthropods (personal observations). Supporting the idea of differential feeding is the variation (namely, in the presence and location or absence of the venom apparatus) in the fingers of the pedipalp: *Garypus* members have a functional venom apparatus in each finger; *Paraliochthonius* members have none in either finger; in *Menthus*

TABLE 2. SYMPATRY OF *Garypus* ON THE PACIFIC COAST OF BAJA CALIFORNIA. Localities arranged north to south.

Locality	*G. californicus*	*G. guadalupensis*	*G. giganteus*	Total number of species
Puerto de Santo Tomás	X			1
Isla de Guadalupe	X	X		2
El Rosario	X			1
Miller's Landing	X		X	2
Laguna Manuela	X		X	2
Isla Asunción	X		X	2
Total number of localities	6	1	3	

members, the venom apparatus occurs in the fixed finger only; *Mexachernes* members have a venom duct in the movable finger only. This structural variation probably influences prey-handling abilities and prey preferences of pseudoscorpions. Assortative feeding, however, is difficult to demonstrate among the sympatric species of *Garypus*.

Zonation of maritime pseudoscorpions is best illustrated by the species represented on a beach on Isla del Espíritu Santo (Fig. 32). A few individuals of *Menthus rossi* were found with the more abundant *Garypus sini* individuals in the supralittoral zone under stones and debris. The former individuals normally inhabit the interior of the island. Occasional individuals of *Garypus sini* were found just below this zone. *Mexachernes carminis* members occupied a zone from the wet-dry line (i.e., where visible sea water seepage is highest) to a level about half the distance to the shore line (i.e., the water's edge), while those of *Paraliochthonius johnstoni* ranged from the wet-dry line to near the shore line. Members of the latter two species are regularly covered by sea water. This zonation pattern is determined by the physiological tolerances of the pseudoscorpions to exposure, dessication, and submergence in sea water (Kensler 1967; Schuster 1962; personal observations).

Dispersal Mechanisms

Pseudoscorpions utilize three methods of dispersal: self-locomotion, phoresy, and rafting.

TABLE 3. SYMPATRY OF MARITIME PSEUDOSCORPIONS ON THE GULF COAST OF BAJA CALIFORNIA. Localities arranged north to south.

Locality	*G. pallidus*	*G. sini*	*G. gracilis*	*P. johnstoni*	*M. carminis*	*S. litoralis*	Total number of species
Granite Island			X				1
Bahía de los Ángeles		X			X		2
Punta Trinidad		X	X				2
Isla de Carmen		X	X	X	X		4
Puerto Escondido		X		X			2
Isla Danzante		X	X		X		3
Isla Monserrate							
northeast side		X	X		X		3
southwest side		X			X	X	3
Isla del Espíritu Santo		X		X	X		3
Isla Cerralvo	X	X					2
Cabo San Lucas	X						1
Total number of localities	2	9	5	3	6	1	

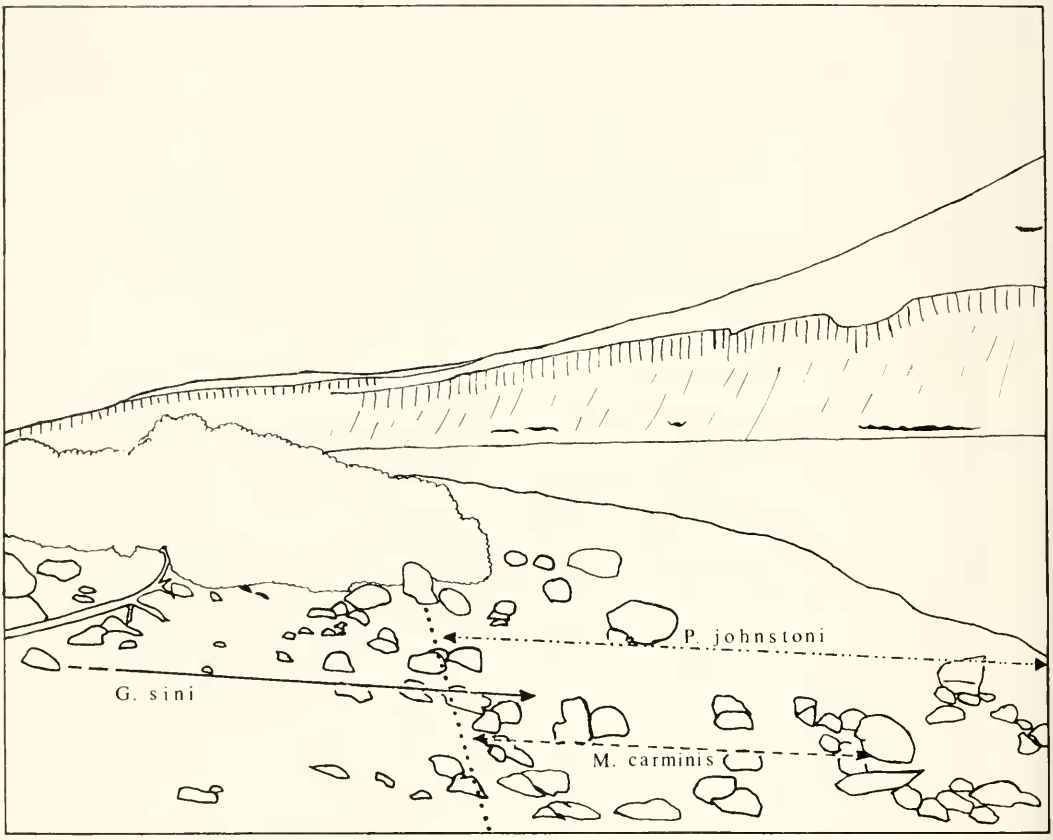


FIGURE 32. Zonation of pseudoscorpions on a beach on the west side of Isla del Espíritu Santo, 28 March 1971. The wet-dry line is indicated by the dotted line. The seaward side of this line actually has many more rocks. Specimens of *Garypus sini* and *Menthus rossi* were found from well above the wet-dry line to just slightly below the wet-dry line. *Mexachernes carminis* and *Paraliochthonius johnstoni* individuals occurred within the wet zone.

Dispersal by wind (anemochore dispersal) has not been shown in pseudoscorpions. Although a pseudoscorpion was collected in a suction trap mounted on a ship which was six kilometers from Santa Catalina Island, California (Guilmette, Holzapfel, and Tsuda 1970), it was probably phoretic on an insect that had been captured by the trap, and had not itself dispersed by wind.

Self-locomotion is the slowest and least effective means of long-range dispersal for pseudoscorpions. Their low vagility and the limitations of suitable microhabitats, especially those of beaches, account for the tendency of pseudoscorpions to remain in very localized areas.

Phoresy ("a nonparasitic association of one kind of animal with another which results in transportation of the smaller by the larger," Muchmore 1971) is commonly used by pseudoscorpions, and the literature abounds with numerous records of this phenomenon. Forest insects have been commonly reported as the hosts. Beier (1948) questioned Fahringer's record of *Garypus beauvoisi* (Savigny) members as passengers on *Apis mellifera* Linnaeus in North Africa. There are no other published records of phoresy by members of the genus *Garypus*. A few pseudoscorpions are known to be phoretic on birds and mammals. Birds, especially in Baja California where they are relatively abundant and undisturbed by human beings, might serve as vectors; but they do not appear to be important vehicles for the dispersal of maritime pseudoscorpions. On some "bird islands" such as Raza and San Pedro Mártir, the only pseudoscorpion represented is a species of *Menthus*, members of which are common in terrestrial habitats only. However, these islands do not

have suitable habitats for typical maritime pseudoscorpions. Conversely, maritime habitats on other islands that support large populations of these pseudoscorpions are not frequented by birds. I know of only two bird–maritime-pseudoscorpion associations. *Garypus titanius* Beier members were found in abundance in the guano deposits of nesting birds on Boatswain Bird Island (or Bos'nbird Islet) in the Ascension Island group (Beier 1961; Stonehouse 1960). A recent collection of *Garypus californicus* specimens from an island near Trinidad, California, which supports a sea-bird colony, suggests the possibility of an avian dispersal agent on this coast (personal notes).

Rafting is the most probable mode of dispersal used by maritime pseudoscorpions. Evidence for this is based on my observations of *Garypus californicus* members on a beach near Bolinas, California. In December 1969, extreme high tides picked up driftwood and wrack and moved them in a southerly direction. The pseudoscorpion population on this beach decreased at this time. In breaking open numerous pieces of driftwood, I found only one pseudoscorpion. In May 1970, on another beach about one kilometer south of the aforementioned beach, I found four *G. californicus* individuals under the bark of a freshly beached driftwood log. Before then, I had not found members of that species on this beach. Strong and Skolmen (1963) cited indirect evidence for the importance of drift logs in long-range dispersal. They have shown that most of the logs washed ashore on Hawaiian beaches originated from western North America, and that other logs there came from the Philippines, southwest Pacific, Japan, and the Malaysian archipelago. Kelp, other marine algae, and plants may also serve as media for transporting pseudoscorpions to new areas, especially those pseudoscorpions which can tolerate prolonged submergence in salt water. Compared with the Gulf side of Baja California, there is much more driftwood, kelp, etc., on the beaches of the Pacific coast side (Evans 1968; personal observations).

Pseudoscorpions which raft must, of course, be able to tolerate submergence in sea water for long periods of time. Members of the typical supralittoral pseudoscorpion species *Garypus californicus* and *G. sini* die after only an hour of submersion (personal observations), whereas those of truly intertidal species can survive much longer. For example, members of *Pselaphochernes litoralis* Beier, a European species, were reported able to survive up to 50 days under such conditions (Schuster 1962). However, *Garypus* or any other pseudoscorpions can extend their survival time if air is trapped in occupied crevices of the transporting medium.

Origins and Phylogenetic Affinities

Due to the limited collections of pseudoscorpions from Baja California and to the fact that their phylogenetic relationships are not well known, the origins of the maritime species can only be superficially analyzed. However, members of the genus *Garypus* lend themselves to some analysis because six species are involved, all of which have members more or less restricted to the supralittoral zone.

The *Garypus* pseudoscorpions of Baja California can be subdivided into two natural groups of species. These groups are based on structural similarity, but also correlate with distinctive geographical distributions: The *californicus* group (two species) ranges from Trinidad, California, to Isla Asunción, Baja California, and on Isla de Guadalupe; the *giganteus* group (four species) occurs in the Bahía de Sebastián Vizcaíno region, around the Cape, and in the Gulf of California. Sympatric areas of the two groups fall within the known range of *G. giganteus*.

The *californicus* group appears to have invaded the area from the north, possibly from Asia. Members of *Garypus japonicus* Beier, known only from Japan (Beier 1952; Takashima 1955), show characteristics that are also found in *G. californicus* and *G. guadalupensis* members, such as the presence of an oblique tarsal articulation on all walking legs, and the ratio of the length of the movable finger to the length of the hand, which is 1.3. It appears that *G. californicus* was derived from the ancestral stock which also gave rise to *G. japonicus*. Members of the populations of *G. californicus* from San Nicolas Island, California, and from Isla de Guadalupe resemble each other, but differ slightly from members of continental populations, mainly in their larger size and ratio of the length of the movable finger to the length of the hand. These populations will be referred to as the island form. It seems that the island form only recently diverged from the continental populations.

Garypus guadalupensis appears to be a descendent of a mainland *G. californicus* stock.

Structural distinctiveness of its members leads me to conclude that it arrived on Isla de Guadalupe, a volcanic island, and diverged at a much earlier time than did the island form of *G. californicus*.

The distribution of the species of the *californicus* group correlates well with oceanic currents (Fig. 1). The clockwise North Pacific gyral is the major oceanic current system affecting the North Pacific Ocean basin. The ancestor of *G. californicus* probably rafted on the Kuroshio Current and the North Pacific Drift from the western Pacific area. At some time in the past, perhaps during Miocene or Pliocene time, when this region was warmer than at present, this ancestor might have drifted directly to the Californian coast or, more probably, "island hopped" (or, specifically, "beach hopped") by way of Beringia. Even at present, the California Current serves to disperse pseudoscorpions in a generally southward direction onto the beaches of the continent and the Pacific islands. However, the Davidson Current, a weak, offshore countercurrent of the California Current, probably prevents continuous southward dispersal of *G. californicus* members when it surfaces during certain times of the year. Also, *G. californicus* members may not be able to tolerate the warmer temperatures of the more southern latitudes. The ancestor of the San Nicolas Island population of *G. californicus* probably rafted there recently. Subsequently, emigrants from this island may have rafted to Isla de Guadalupe. The ancestor of *Garypus guadalupensis* probably rafted to Isla de Guadalupe at a much earlier time, but the source area is unknown.

The *giganteus* group probably had its origins in the neotropical Pacific, although there are no records of *Garypus* from beaches on the Pacific coast of the New World south of Oaxaca. If we assume a Pacific tropical origin for the group, the north-flowing coastal components of the North Equatorial Current and the Equatorial Countercurrent may have rafted the group ancestors from this area into the Gulf. The occurrence of *G. giganteus* in the region of Bahía de Sebastián Vizcaíno may be attributed to the Davidson Current. This current is usually a deep countercurrent located below 200 meters (Reid, Roden, and Wyllie 1958). During late fall and early winter when the north winds are weak or absent, this countercurrent rises to the surface in an area from the tip of the Baja peninsula to Point Conception, California. During this time of the year, the ancestors of *G. giganteus* may have rafted onto the beaches on the Pacific side of Baja California.

The other three species of the *giganteus* group probably invaded the Gulf area along two lines. First, the precursors of *G. sini* and *G. gracilis* may have rafted onto the newly exposed beaches of the Gulf after the Baja land mass broke away from the mainland states of Sonora, Sinaloa, and Jalisco, about four to ten million years ago (late Miocene–Pliocene) (Hamilton 1961). It is difficult to decide, at the present time, whether these precursors invaded the beaches from outside the Gulf concurrently or at different times, or whether *G. gracilis* speciated from the stock that also gave rise to *G. sini* somewhere inside the Gulf. (I favor the latter hypothesis.) If *G. gracilis* were an autochthonous species, it probably speciated allopatrically on the islands of the Gulf. I doubt that sympatric speciation occurred because the food and habitat requirements of *Garypus* pseudoscorpions are not very specialized. At present, *G. gracilis* members are less abundant than those of *G. sini*, suggesting that the latter may be displacing the former.

Garypus pallidus members are quite distinct from members of their sister species of the *giganteus* group. *G. pallidus* represents the second wave of invasion. The present-day distribution of this species suggests that it recently rafted onto the beaches around the Cape after *G. sini* and *G. gracilis* had established themselves in the Gulf.

Menthus lindahli individuals appear to be only occasional intruders in the supralittoral zone, but further collecting should be made to verify this. In any event, this species is a representative of a predominantly terrestrial genus.

A comparison of the habitat preferences of members of all known species of *Serianus* suggests that *S. litoralis* was probably derived from a terrestrial form. The notably disjunct distribution of this species can be explained in two ways. By some form of long-range dispersal, possibly introduction by fishing persons or by rafting, individuals may have been transported from the Mazatlán area to Isla Monserrate, or vice versa. The other explanation is based on continental drift. Before late Miocene–Pliocene, the Baja peninsula was attached to the Mexican mainland at an area in the present states of So-

nora and Sinaloa, with the tip joined to the bulge offshore at Jalisco (Hamilton 1961). At that time, the two localities from which *S. litoralis* is currently known were roughly opposite each other. Now they are about 560 kilometers apart, separated by sea water and latitude. Although substantial evidence is not yet available to support either one or both of these hypotheses, it seems reasonable to assume that the present population on Isla Monserrate is a relict of a wider distribution on neighboring islands. To date, the shore of the Mexican mainland have not been as fully investigated as the Gulf islands and shores of the peninsula.

Two species of *Paraliochthonius* Beier are known from the littoral areas bordering the Pacific Ocean: *P. johnstoni* from Baja California and *P. takashimai* (Morikawa) from Japan. These species follow an amphipacific distribution as do members of the *Garypus californicus* group. Hence, their distributions also seem to correlate with major currents of the North Pacific. Other species assignable to *Paraliochthonius* are found in intertidal areas of the Atlantic Ocean (Muchmore 1972). Although Muchmore (1972) synonymized *Morikawia* Chamberlin (type-species: *Chthonius johnstoni* Chamberlin) with *Paraliochthonius* (type-species: *Chthonius singularis* Menozzi), several species previously described in genus *Morikawia* were reported from upland areas of the Australian region and the Philippine Islands. They probably should be referred to a genus other than *Paraliochthonius*.

It is probable that *Mexachernes carminis* was derived from a terrestrial ancestor, but additional data and hopefully, the discovery of new, related forms are needed to support this conclusion.

In summary, I suggest that precursors of the present pseudoscorpion fauna of the Gulf of California invaded the beaches some time after late Miocene–Pliocene, when the Baja peninsula began rafting away from mainland México. One route was by sea. As shown in the previous discussion, most of the maritime pseudoscorpions are probably able to raft from one area to another. The other route, by land, was probably taken by forms such as *Serianus litoralis* and *Mexachernes carminis*. These species were probably derived from terrestrial ancestors. The increasing aridity of the peninsula and islands very likely drove their ancestors to the moister areas of the littoral and supralittoral zones.

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